2nd International Conference on Materials Research and Innovation (2nd ICMARI)

BOOK OF ABSTRACTS

Organized by

1. Specialized center of Rubber and Polymer Materials in agriculture and industry (RPM), Faculty of Science, Kasetsart University, Bangkok, Thailand.
2. National Research Council of Thailand (NRCT).
3. Thailand Science Research and Innovation (TSRI).
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PREFACE

The 2nd International Conference on Materials Research and Innovation (2nd ICMARI) will be held on 16th – 18th December 2019 in Bangkok, Thailand. The conference will be conducted in frontier research on materials research and Innovation including Rubbers and Composites, Biomaterials, Materials of Energy and Environmental Applications, Computational Model and Simulations, Industrial Innovation, and Special Advanced Materials. This 2nd ICMARI was announced in order to created and build up collaboration network and sharing experience among researchers in ASEAN and around the world. It is a great opportunity for all participants to exchange knowledge and strengthen the research collaboration. We hope that the participants will be fruitful by plenary and invited speakers in knowledge, application, novel technology in the field of materials research and innovation.

Thank you all for participating

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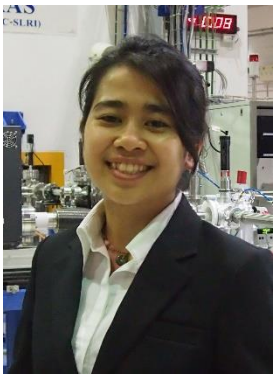

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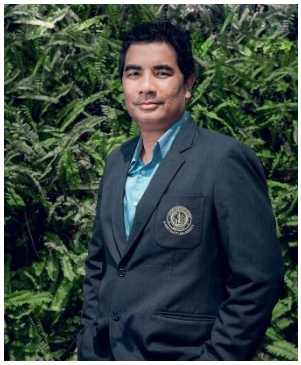

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PROGRAM

Program of International Conference on Materials Research and Innovation

16th – 17th December 2019 at Centara Grand Central Plaza Ladprao, Bangkok, Thailand

18th December 2019 at 341 room SC45 Building Kasetsart University, Bangkok, Thailand

Monday 16th December 2019

08.00-09.00	**Registration**
09.00-10.15	**Opening ceremony** Vibhavadee Ballroom C Welcome speech: ***Dr. Chongrak Wachrinrat,*** *(Acting President of Kasetsart University)* Opening speech: ***Dr. Suvit Maesincee***, *(Minister of Ministry of Higher Education, Science, Research and Innovation)*
10.15-10.45	**Plenary lecture:** Design of polymer-derived nanoparticles, nanorods, and porous microparticles Vibhavadee ballroom C *Prof. Sadhan C. Jana** *Department of Polymer Engineering, the University of Akron, USA*
10.45-11.00	**Coffee break**
	Rubbers and Composites 1 Vibhavadee Ballroom C **Session chairs:** Krisda Suchiva and Orasa Onjun
11.00-11.30	**Invited lecture:** Research and Development to Reduce the Weights of Solid Tyres *Krisda Suchiva**, *Chakrit Sirisinha, Sira Meesaringkarn* *Mahidol University, Thailand*
11.30-12.00	**Invited lecture:** The development of radiation shielding products from natural rubber *Orasa Onjun[1,]*, Orawan Pinprayoon[1], Nichapa Buasuwan[1], Thiti Rungseesumran[2], Natthaporn Kamwang[2], Jatechan Channuie[2]* *[1]Department of Science Service; [2] Thailand Institute of Nuclear Technology, Thailand*
12.00-12.20	**O-01:** Effect of composition ratios and mixing steps on properties of BR/NR/NBR blends and blends foam *Chanchai Thongpin* , Kridsana Jumpathong, Rapeepat Jaroenjai, Wongpat Bunwanna, Jedtarin Jaroenta* *Silpakorn University, Thailand*
12.20-14.00	**Lunch**
	Rubbers and Composites 2 Vibhavadee Ballroom C **Session chairs:** Li Jia and Wirunya Keawwattana
14.00-14.30	**Invited lecture:** Non-silane coupling agents for silica reinforcement of rubber *Li Jia** *Department of Polymer Science, University of Akron, USA*
14.30-14.50	**O-02:** High pressure crystallization of nucleated polypropylene and polypropylene nanocomposites in the gamma-form *Ewa Piorkowska[1,]*, Przemyslaw Sowinski[1], Severine A.E. Boyer[2], Jean-Marc Haudin[2], Konrad Kwiecinski[1]* *[1]Polish Academy of Sciences, Poland; [2]PSL – Research University, France*

14.50-15.10	**O-03:** Assessment of human health impact based on life cycle assessment: A case study of Thai retread tire. *Weerawat Ounsaneha[1] , Tarinee Buadit[2] , Cheerawit Rattanapan[2,]** *[1]Valaya Alongkorn Rajabhat University under the Royal Patronage; [2]Mahidol University, Thailand*
15.10-15.30	**O-04:** Enhancement of the tyre rolling resistance testing machine *Supachai Lakkam*, A Tempiem* *Rajamangala University of Technology Phra Nakhon, Thailand*
15.30-15.45	**Coffee Break**
	Rubbers and Composites 3 Vibhavadee Ballroom C **Session chairs:** Karine MOUGIN and Nanthiya Hansupalak
15.45-16.15	**Invited lecture**: Enhancement of the compatibility between natural rubber and pineapple leaf microfibers for better stress transfer in their composite *Karine MOUGIN** *Institute de Science des Materiaux de Mulhouse, France*
16.15-16.35	**O-05:** A wide energy range neutron shielding material based on natural rubber and boron *Chayanit Jumpee[1,]* , Tithinun Rattanaplome[1], Natthaporn Kumwang[2]* *[1]Chiang Mai University; [2]Thailand Institute of Nuclear Technology (Public Organization), Thailand*
16.35-16.55	**O-06:** Using of polymer blends base on natural rubber latex/acrylic emulsion as binder for building paint *Anuwat Worlee[1,2,]*, Narongrit Homdong[2] , Nabil Hayeemasae[3]* *[1]Fatoni University; [2]Thailand Institute of Scienctific and Technological Research;* *[3]Faculty of Science and Technology, Thailand*
16.55-17.15	**O-07:** Study on processability and mechanical properties of parawood-power filled PLA for 3D printing material *Kanjanaphorn Chansoda, Watcharapong Chookaew** *Mahidol University, Thailand*
17.15-17.35	**O-08:** Effect of acrylonitrile butadiene rubber on the properties of silica-reinforced natural rubber *Karnda Sengloyluan* , Ossanee Sangampai, Nattapon Uthaipan, Varapon Tanrattanekul* *Prince of Songkla University, Thailand*
17.35-17.55	**O-09:** On the mechanical properties of para rubber-oil palm ash derived geosynthetic clay liner *Panu Promputthangkoon[1],*, Adisai Rungvichaniwat[2], Nomchit Kaewthai Andrei[1], Tavorn Kuasakul[1]* *[1]Rajamangala University of Technology Srivijaya; [2]Prince of Songkhla University, Thailand*
	Materials of Energy and Environmental Applications 1 Rungsit 1 room **Session chairs:** Parames Kamhangrittirong and Sopa Visitsak
11.00-11.30	**Invited lecture**: Development of a manual for rubber plantation owners and rubber wood consumers in Thailand for obtaining international forest management certification *Khanchai Duangsathaporn** *Kasetsart University, Thailand*

11.30-12.00	**Invited lecture:** Eco-friendly wall materials produced from forestry wastes and natural binder *Sopa Visitsak*,* *Kasetsart University, Thailand*
12.00-12.20	**O-10:** Acoustic board from sea oak *Ruengrumpa Intaraksa[1], Parames Kamhangritirong[2], Kanokon Hancharoen[2]* *[1]Rajamanggala University of Technology Srivijaya; Kasetsart University, Bangkok, Thailand*
12.25-14.00	**Lunch**
	Materials of Energy and Environmental Applications 2 Rungsit 1 room **Session chairs:** Katsura Nishiyama and Patthra Pengthamkeerati
14.00-14.30	**Invited lecture:** Synthesis of nanosale photoenergy conversion materials –from biomarkers to afterglow devices– *Katsura Nishiyama** *Meijo University, Japan*
14.30-14.50	**O-11:** Injection-molded polyethylene/natural rubber blends *Rangrong Yoksan*,* *Kasetsart University, Thailand*
14.50-15.10	**O-12:** Effect of Fe doping on photocatalytic activity of TiO_2 hollow fibers under LED light irradiation *Sittan Wongcharoen[1] , Gasidit Panomsuwan[1,]*, Chayanaphat Chokradjaroen[2]* *[1]Kasetsart University, Thailand; [2]Shibaura Institute of Technology, Japan*
15.10-15.30	**O-13:** Performances of cellulose nanofiber reinforced composites prepared by Pickering emulsification *Supachok Tanpichai[1, 2,]*, Subir Kumar Biswas[2], Hiroyuki Yano[2]* *[1]King Mongkut's University of Technology Thonburi, Thailand; [2]Kyoto University, Gokasho, Japan.*
15.30-15.45	**Coffee Break**
	Materials of Energy and Environmental Applications 3 Rungsit 1 room **Session chairs:** Jukkit Mahujchriyawong and Chanchana Thanachayanont
15.45-16.15	**Invited lecture:** Hybrid Materials for Hand-held Pesticide Detection *Chanchana Thanachayanont[1]*, Seeroong Prechanont[2], Bralee Chayasombat[1], Kroekchai Inpor[1], Nongluck Houngkamhang[3]* *[1]National Metal and Materials Technology Center; [2]Chulalongkorn University, [3]King Mongut's Institute of Technology Ladkrabang, Thailand*
16.15-16.35	**O-14:** Removal of fluoride ions from groundwater using surface-modified ultrafiltration membrane *Wararat Yanwachiragul[1], Jenyuk Lohwacharin[1,]*, Warayuth Sajomsang[2], Sudkanueng Singto[2]* *[1]Chulalongkorn University; [2]National Nanotechnology Center, Thailand*
16.35-16.55	**O-15:** Enhanced interfacial dielectric polarization in PVDF-HFP copolymer with treating PPy by using silane coupling agent *Ahamad Salea[1] , Rakha Saputra[1,2] , Chatchai Putson[1,]** *[1]Prince of Songkla University, Thailand; [2]UIN Sunan Kalijaga Marsda Adisucipto street, Indonesia*
	Computational Model and Simulations 1 Rungsit 2,3 room **Session chairs:** Norio Yoshida and Saree Phongphanphanee

11.00-11.30	**Invited lecture**: Development of multiscale method for nano-bio materials design based on statistical mechanics theory of molecular liquids *Norio Yoshida** *Kyushu University, Japan*
11.30-11.50	**O-16:** The modification of steel belt layer of airless tire for finite element analysis *Juthanee Phromjan , Chakrit Suvanjumrat** *Mahidol University, Thailand*
11.50-12.10	**O-17:** Mathematical model for decision making in production of upstream Para rubber product in the supply chain Case Study: Pluak daeng district, Rayong *Srisawat Sapsomboon** *King Mongkut's University of Technology North Bangkok, Thailand*
12.10-14.00	**Lunch**
	Computational Model and Simulations 2 Rungsit 2,3 room **Session chairs:** Ryo Akiyama and Jirasak Wong-ekkabut
14.00-14.30	**Invited lecture**: Statistical mechanics study of separation of inert solvent mixtures by a porous material *Ayano Chiba[1], Akio Oshima[2], Kenzaburo Okubo[2], Ryo Akiyama[2,*]* *[1]Keio University; [2]Kyushu University, Japan*
14.30-14.50	**O-18:** The use of physical simulation to evaluate thermal properties of food containers in cold chain logistics *Ninlawan Chaitanoo[1], Pornthipa Ongkunaruk[2,*], Duke Leingpibul[3]* *[1]Rajamangala University of Technology Lanna; [2]Kasetsart University, Thailand;* *[3]Western Michigan University, USA*
14.50-15.10	**O-19:** Monte Carlo simulations of nanorod filler in stretched polymer nanocomposites *Nathanon Kerdkaen [1,2], Thana Sutthibutpong [3,*], Saree Phongphanphanee[1], Sutee Boonchui [1], Jirasak Wong-ekkabut [1,3,*]* *[1]Kasetsart University; [2]Ministry of Higher Education,Science, Research and Innovation; [3]King Mongkut's University of Technology Thonburi,*
15.10-15.30	**O-20:** Solvation of cellobiose in salt/DMAc and salt/water/DMAc *Saree Phongphanphanee** *Kasetsart University, Thailand*
15.30-15.45	**Coffee Break**
	Computational Model and Simulations 3 Rungsit 2,3 room **Session chairs:** Tsuyoshi Yamaguchi and Sutee Boonchui
15.45-16.15	**Invited lecture:** Relation between mesostructure and viscoelasticity of ionic liquids *Tsuyoshi Yamaguchi** *Nagoya University, Japan*
16.15-16.35	**O-21:** Transmission of charge ion in single-walled carbon nanotube *Jakkapong Cheroenpakdee, Sutee Boonchui** *Kasetsart University, Thailand*
16.35-16.55	**O-22:** Electromagnetic interaction between talcum particle and a topological insulator *Chayanon Summueang, Sutee Boonchui** *Kasetsart University, Thailand*

16.55-17.15	**O-23:** The material-point method for colloids in liquid rubber foam in the equilibrium state *Natthaphol Kamolsiriwat, Sutee Boonchui** *Kasetsart University, Thailand*

Tuesday 17th December 2019

08.00-09.00	**Registration**
09.00-09.30	**Plenary lecture:** Nanomechanisms of plastic deformations of polymers. Ladprao Suite room *Prof. Andrzej Galeski** *Polish Academy of Sciences, Poland*
09.30-10.00	**Plenary lecture:** Exploring life phenomena woven by water and biomolecules Ladprao Suite room *Prof. Fumio Hirata** *Toyota Physical and Chemical Research Institute & Institute for Molecular Science, Japan*
10.00-10.15	**Coffee Break**
	Biomaterials 1 Ladprao 1-2 room **Session chairs:** Arkadiusz Chworos and Chomdao Sinthuvanich
10.15-10.45	**Invited lecture**: RNA nanostructures for responsive therapeutics *Arkadiusz Chworos** *Polish Academy of Sciences, Poland*
10.45-11.15	**Invited lecture**: A swarm molecular robot constructed from photo-sensor, DNA processor and biomolecular motor *Akira Kakugo** *Hokkaido University, Japan*
11.15-11.35	**O-24:** Effect of polymer and salt concentrations on heterogeneous degradation of chitosan powder by solution plasma *Chayanaphat Chokradjaroen[1,2,]*, Ratana Rujiravanit[2], Jidapa Chantaramethakul[3], Gasidit Panomsuwan[3], Hiroharu Yui[4], Nagahiro Saito[5]* *[1]Shibaura Institute of Technology, Japan; [2]Chulalongkorn University; [3]Kasetsart University, Thailand;* *[4]Tokyo University of Science; [5]Graduate School of Engineering, Japan*
11.35-11.55	**O-25:** Role of Sn-based and Ti-based catalysts on melt copolymerization of PLA-Polyols *Jakkrawut Luangkachao, Kalyanee Sirisinha** *Mahidol University, Thailand*
11.55-12.15	**O-26:** Preparation of lectin-recognition hydrogel layers on SPR sensor chips by molecular imprinting using carbohydrate ligands *Rinyarat Naraprawatphong[1], Nagahiro Saito[1], Akifumi Kawamura[2], Takashi Miyata[2,]** *[1]Nagoya University; [2]Kansai University, Japan*
12.15-14.00	**Lunch**
	Biomaterials 2 Ladprao 1-2 room **Session chairs:** Darshil U. Shah and and Chanapa Kongmark

14.00-14.30	**Invited lecture:** The wonders of Silk: Developing tomorrows advanced biomaterials, foams and composites *Darshil U. Shah** *Centre for Natural Material Innovation, University of Cambridge, England*
14.30-15.00	**Invited lecture** Bio based thermoplastic vulcanizates from natural rubber (NR/bioplastic) *Chanchai Thongpin[1,2,*], Kwanchai Buaksuntear[1], Theraphat Tanprasert[1], Jedtarin Charoenta[1,2]* *[1]Silpakorn University; [2]Chulalongkorn University, Thailand*
15.00-15.20	**O-27:** Two dimensional crystallization of Bacteriorhodopsin by depletion force *Keiju Suda[1], Ayumi Suematsu[2], Ryo Akiyama[1,*]* *[1]Kyushu University; [2]Kyushu Sangyo University, Japan*
15.20-15.40	**O-28:** Non-destructive assessment of moisture content and modulus of rupture of sawn timber *Hevea* wood using near infrared spectroscopy technique *Sutida Ruangkhasap, Sirinad Noypitak*, Worawat Noknoi, Anupun Terdwongworakul* *Kasetsart University, Thailand*
15.40-15.55	**Coffee Break**
	Biomaterials 3 Ladprao 1-2 room **Session chairs:** Kensuke OSADA and Nattasamon Petchsang
15.55-16.25	**Invited lecture:** Control of versatile higher-ordered structures of pDNA by block copolymers and their application as gene delivery system *Kensuke OSADA** *National Institutes for Quantum and Radiological Science and Technology (QST), Japan*
16.25-16.45	**O-29:** An accelerated biodegradation of Poly(lactic acid) by inoculation of *Pseudomonas* geniculate WS3 combined with nutrient addition *Yeiangchart Boonluksiri[1,*], Benjaphorn Prapagdee[2], Narongrit Sombatsompop[1]* *[1]King Mongkut's University of Technology Thonburi (KMUTT); [2]Mahidol University, Thailand*
16.45-17.05	**O-30:** Production of cellulose microfibers from cassava bagasse *Kamolsit Chumnitulakarn, Athitaya Homyuen, Prakit Sukyai** *Kasetsart University, Thailand*
17.05-17.25	**O-31:** Extraction of lignin-containing cellulose nanocrystals from sugarcane bagasse *Kunat Kongsin, Rungsima Chollakup, Prakit Sukyai** *Kasetsart University, Thailand*
17.25-17.45	**O-32:** Cellulose nanocrystals isolation and application in painting *Nalintip Imchalee, Ratthapong Meesupthong, Prakit Sukyai** *Kasetsart University, Thailand*
17.45-18.05	**O-33:** Production of calcium carbonate from sugar industry *Chalisa Panapitakkul, Selorm Torgbo, Prakit Sukyai** *Kasetsart University, Thailand*
18.05-18.25	**O-34:** The effect of Lactobacillus plantarum on cellulose extraction *Yuranan Boonjan, Nat Amornnopparattanakul, Prakit Sukyai** *Kasetsart University, Thailand*
	Industrial Innovations 1 Ladprao 3-4 room **Session chairs:** Matthias Kress and Nanthiya Hansupalak

10.15-10.45	**Invited lecture**: Confocal Raman imaging for biological and life science research *Matthias Kress** *Director Sales Asia, WITec, Germany*
10.45-11.05	**O-35:** The study of a small-sized Thai chili paste supply chain *Jirayu Srilarp, Pornthipa Ongkunaruk** *Kasetsart University, Thailand*
11.05-11.25	**O-36:** The analysis of a chilled beef supply chain for developing strategic improvement *Rendayu Jonda Neisyafitri, Pornthipa Ongkunaruk ** *Kasetsart University, Thailand*
11.25-11.45	**O-37:** The improvement of a high value-added supply chain: a cordyceps beverage case study *Poowanat Poochinya, Pornthipa Ongkunaruk** *Kasetsart University, Thailand*
11.45-12.05	**O-38:** Design approach using finite element method with 3D printing validation *Jaruwan Bumrungpheud, Watcharapong Chookaew** *Mahidol University, Thailand*
12.05-14.00	**Lunch**
	Industrial Innovations 2 Ladprao 3-4 room **Session chairs:** Pataraporn Tanapavarrit
14.00-14.30	**Invited lecture:** Accreditation supports to the supply chain *Pataraporn Tanapavarrit** *The Department of Science Service, Thailand*
14.30-14.50	**O-39:** Impact absorbing kneepad prepared from natural rubber *Kaewpradit, P.**, Kongchoo, A., Chonlathan, P., Lehman, N., E. Kalkornsurapranee* *Prince of Songkla University, Thailand*
14.50-15.10	**O-40:** A new internal stress control drying technique of rubberwood lumber *Nirundorn Matan[1,]*, Jaipet Tomad[1], Sataporn Jantawee[2], Taweesin Wongprot[1], Choosak Rittiphet[1]* *[1]Walailak University; [2]Nakhon Si Thammarat Rajabhat University, Thailand*
15.10-15.30	**O-41:** A development of automatic builder machine for retreaded tire manufacturing *Chatpun Kamyat, Chana Raksiri*, Ratchapon Masakasin* *Kasetsart University, Thailand*
15.30-15.45	**Coffee Break**
	Industrial Innovations 3 Ladprao 3-4 room **Session chairs:** Wanwisa Limphirat
15.45-16.15	**Invited lecture:** Synchrotron application for material researches and Innovation *Wanwisa Limphirat** *Synchrotron Light Research Institute, Thailand*
16.15-16.35	**O-42:** Application of Kawabata evaluation system for the tactile properties of woven silk fabrics in textile industry *Pithalai Phoophat*, Pimpawan Kumphai, Suntaree Suwonsichon,* *Jirachaya Boonyarit, Chonlakorn Plangmon, Rungsima Chollakup* *Kasetsart University, Thailand*

16.35-16.55	**O-43:** Mechanical characteristics of airless tire by laboratory testing *Ravivat Rugsaj, Chakrit Suvanjumrat ** *Mahidol University, Thailand*
16.55-17.15	**O-44:** UV-protection property of Eri silk fabric dyed with natural dyes for eco-friendly textiles *Nattadon Rungruangkitkrai[1], Rattanaphol Mongkholrattanasit[2] , Pithalai Phoophat[1] , Sivilai Sirimungkararat[3], Kasorn Wongkasem[4] , Pawarin Tuntariyanond[1] , Nattawat Nithithongsakol[5] Rungsima Chollakup[1,*]* *[1]Kasetsart University; [2]Rajamangala University of Technology Phra Nakhon; [3]Mahasarakham University; [4]Khon Kaen University; [5]Natural Niche Co., Ltd., Thailand*
17.15-17.35	**O-45:** Rubberwood Sawdust Filled Natural Rubber Composites: Effects of Filler Loading and Zinc Oxide Content *Chatree Homkhiew[1,*], Ekkawit Pianhanuruk[1], Surasit Rawangwong[1], Worapong Boonchouytan[1], Rittichai Numrat[2]* *[1]Rajamangala University of Technology Srivijaya; [2]Plan Creations Co., Ltd., Thailand*
17.35-17.55	**O-46:** Impact of legislative measures for cess management in rubber industry *Suphatut Srivipatana[1,*], Natthavika Chansri[2]* *[1]Burirum Rajabhat University; [2]Kasetsart University Sriracha Campus, Thailand*
	Special Advanced Materials 1 Krungthep 3 room **Session chairs:** Youli Li and Sutee Boonchui
10.15-10.45	**Invited lecture**: Highly ordered nanostructures of lipo-complexes of oligo-DNA driven by membrane undulations *Youli Li** *University of California at Santa Barbara, USA*
10.45-11.15	**Invited lecture**: Oxide nanosheets for functional soft materials *Nobuyoshi MIYAMOTO** *Fukuoka Institute of Technology, Japan*
11.15-11.35	**O-47:** High selectivity ethylene gas sensors for fruit ripening application *Pimpan Leangtanom[1], Narong Chanlek[2], Anurat Wisitsoraat[3,4], Kata Jaruwongrungsee[5], Viruntachar Kruefu[1,*]* *[1]Maejo University, Thailand; [2]Synchrotron Light Research Institute, Thailand; [3]National Science and Technology Development Agency, Thailand; [4]Thammasat University, Thailand; [5]National Electronics and Computer Technology Center (NECTEC), Thailand*
11.35-11.55	**O-48:** High calcium fly ash geopolymer containing natural rubber latex as additive *Charoenchai Ridtirud** *Rajamangala University of Technology Isan, Thailand*
11.55-12.15	**O-49:** Y_2BaCuO_5 particle size control via ultrasonication and its effect on bulk $YBa_2Cu_3O_y$ superconductors *Sunsanee Pinmangkorn, Miryala Muralidhar*, Arvapalli Sai Srikanth, Masato Murakami* *Shibaura Institute of Technology, Japan*
12.15-14.00	**Lunch**
	Special Advanced Materials 2 Krungthep 3 room **Session chairs:** H. M. Yamamoto and Jirasak Wong-ekkabut

14.00-14.30	**Invited lecture**: Glycoengineering based on biomolecular molecular science *Koichi Kato[1,2,3,*], Tatsuya Suzuki[1,3], Tokio Watanabe[3], Taiki Saito[1,3], Gengwei Yan[1,2], Tadashi Satoh[4], Saeko Yanaka[1,2,3], Hirokazu Yagi[3], Takumi Yamaguchi[3,4]* *[1]National Institutes of Natural Sciences; [2]SOKENDAI; [3]Nagoya City University; [4]Japan Advanced Institute of Science and Technology, Japan*
14.30-15.00	**Invited lecture**: Organic Spin Filter Based on Motor Molecule *M. Suda[1,2,3], Y. Thathong[4], V. Promarak[4,5], H. Kojima[6], M. Nakamura[1,6], T. Shiraogawa[1,3], M. Ehara[1,3], H. M. Yamamoto[1,2,3,*]* *[1]Institute for Molecular Science, Japan; [2]RIKEN, Japan; [3]SOKENDAI (Graduate University for Advanced Studies), Japan; [4]Suranaree University of Technology, Thailand; [5]Vidyasirimedhi Institute of Science and Technology (VISTEC), Thailand; [6]Nara Institute of Science and Technology, Japan*
15.00-15.20	**O-50:** Graphene foam filter for PM 2.5 capture *Thararat Naksakul[1], Plymeena Sunpong[2], Akkawat Ruammaitree[1,*]* *[1]Thammasat University; [2]Burapha University, Thailand*
15.20-15.45	**Coffee Break**
	Special Advanced Materials 3 Krungthep 3 room **Session chairs:** Hisashi Okumura and Saree Phongphanphanee
15.45-16.15	**Invited lecture:** Molecular insight into protein aggregation by computer simulation *Hisashi Okumura[1,2,3,*]* *[1]Exploratory Research Center on Life and Living Systems; [2]Institute for Molecular Science; [3]SOKENDAI (The Graduate University for Advanced Studies), Japan*
16.15-16.35	**Invited lecture**: Bandgap Science for Organic Solar Cells *Masahiro Hiramoto*, Seiichiro Izawa* *Institute for Molecular Science, Japan*
16.35-16.55	**Invited lecture**: Energy and spatial distribution of frontier orbital state for organic thin films *Satoshi Kera[1,2,*]* *[1]Institute for Molecular Science; [2]SOKENDAI, Japan*
16.55-17.15	**O-51:** Natural rubber human phantom for cancer treatment radiation dose verification of radiation therapy *Nuntawat Udee*, Sararat Mahasaranon* *Naresuan University, Thailand*

POSTER SESSIONS

16th December 2019

17.30-20.00	**Poster Sessions and Cocktail party (announcement of the Best Poster Award)** Ladprao Suite room
	P-01: Biobased composite from poly(butylene succinate) and peanut shell waste adding maleinized linseed oil *Nattakarn Hongsriphan*, Preeyanan Kamsantia, Pornnatcha Sillapasangloed, Samita Loychuen* *Silpakorn University, Thailand*
	P-02: Surface plasmon resonance sensor based on core-shell metal nanorods *Yuan-Fong Chou Chau*,* *Universiti Brunei Darussalam, Brunei Darussalam*

P-03: Chitosan/regenerated silk fibroin films as a biomaterial for daily disposable contact lenses-based ophthalmic drug delivery system

Rachasit Jeencham[1,2], Manote Sutheerawattananonda[3], Waree Tiyaboonchai[1,2,]*
[1]Naresuan University, Thailand; [2]Ministry of Education; [3]Suranaree University of Technology, Thailand

P-04: The growth of graphene on stainless steel by chemical vapor deposition using soybean oil as a carbon source

*Akkawat Ruammaitree**
Thammasat University, Thailand

P-05: Facile preparation of magnetic carbon nanofiber composite from Nata-de-coco for removal of methylene blue dye from water

Piyatida Thaveemas[1], Laemthong Chuenchom[1], Supanna Techasakul[2], Decha Dechtrirat[2,3,]*
[1]Prince of Songkla University; [2]Chulabhorn Research Institute; [3]Kasetsart University, Thailand

P-06: Characterization of polylactic-epoxidized natural rubber/modified cellulosic fiber biocomposites with different silane coupling agents

Suding Kadea[1], Jariya Seekaew[1], Sittipon Thongmala[1], Rattanawadee Hedthong[1] , Nattaporn Khanoonkon[2], Suteera Witayakran[2], Pathama Chatakanonda[2], Rungsima Chollakup[2], Thorsak Kittikorn[1,]*
[1]Prince of Songkla University, Thailand; [2]Kasetsart University, Thailand

P-07: Effects of post-gamma irradiation on swelling and mechanical properties of gamma vulcanized natural rubber latex (GVNRL) films

*Gunyarat Wicha[1], Kanyapuk Intharaprasit[1], Ekachai Wimolmala[2], Teerasak Markpin[2], Kiadtisak Saenboonruang[1],**
[1]Kasetsart University; [2]King Mongkut's University of Technology Thonburi, Thailand

P-08: Determination of radioactivities in gamma vulcanized natural rubber latex (GVNRL) for the assessment of radiological safety

*Donruedee Toyen, Kiadtisak Saenboonruang **
Kasetsart University, Thailand

P-09: Facile preparation of monolithic magnetic porous carbon acid catalysts via surface self-assembly method and their applications in conversion of xylose into furfural

Piyamit Toumsri[1], Joongjai Panpranot[2], Laemthong Chuenchom[1,]*
[1]Prince of Songkla University; [2]Chulalongkorn University, Thailand

P-10: Surface modification of poly(amidoamine) dendrimer to enhance the anti-proliferative activity

Chaiyawat Aonsri[1], Chuda Chittasupho[2], Witcha Imaram[1,]*
[1]Kasetsart University; [2]Srinakharinwirot University, Thailand

P-11: Preparation and ferroelectric properties of Poly (vinylidene fluoride-hexafluoropropylene) (PVDF-HFP) filled with graphene-nanoplatelets film composites

*Suphita Chaipo, Chatchai Putson**
Prince of Songkla University, Thailand

P-12: Comparative X-ray shielding properties of bismuth oxide/natural rubber composites using a Monte Carlo code of PHITS

Donruedee Toyen[1], Kiadtisak Saenboonruang[2,]*
[1]Kasetsart University Research and Development Institute; [2]Kasetsart University, Thailand

P-13: Effect of zeolite types on properties of polybutylene succinate/polylactic acid films

R. Preedanorawut, P. Threepopnatkul, A. Sittatrakul*

Silpakorn University, Thailand

P-14: Apatite inducing ability on silk fabric and its ammonium gas adsorptivity

*Charkrit Thongbai, Suwapitcha Buntham, Chawalit Ngamcharussrivichai, Dujreutai Pongkao Kashima**
Chulalongkorn University, Thailand

P-15: Effects of sintering temperature on microstructure of TiO_2 scaffold

*Suttinattha Yanawarutwong, Dujreutai Pongkao Kashima**
Chulalongkorn University, Thailand

P-16: ZnO-g-C_3N_4 -Fe_3O_4 photocatalyst composites embedded polyvinyl alcohol/sodium alginate beads for efficient of photodegradation

*Sukanya Ninpet, Suntree Sangjan**
Kasetsart University Kamphaeng Saen campus, Thailand

P-17: The utilization of wastewater from fermented rice noodle manufacturing process for the production of bacterial cellulose by *Acetobacter xylinim* TISTR 975

*Tanaporn Pongjinapeth, Pipat Sudying, Phimchanok Jaturapiree**
Silpakorn University, Thailand

P-18: Study of rubber/calcium carbonate composite

*Nantikan Phuhiangpa, Saree Phongphanphanee, Wirasak Smitthipong**
Kasetsart University, Thailand

P-19: The effect of hydroxylamine sulfate on the storage hardening of natural rubber

*Khwanchat Promhuad, Wirasak Smitthipong**
Kasetsart University, Thailand

P-20: The effect of non-rubber components on mechanical properties of TESPD silane coupling agent in silica-filled rubber compounds

*Sirawan Kaewsikoun, Sirirat Kumarn, Jitladda Sakdapipanich**
Mahidol University, Thailand

P-21: Confirmation molecular structure of the *Hevea* rubber molecule and its effects in storage hardening

*Preeyanuch Theamsawade, Sirirat Kumarn, Jitladda Sakdapipanich**
Mahidol University, Thailand

P-22: Studies on the effect of purified natural rubber latex and accelerators on rubber allergens in natural rubber dipping product

*Jinjutha Wiriyanantawong, Phattara-orn Havanapan, Chartchai Krittanai, Jitladda Sakdapipanich**
Mahidol University, Thailand

P-23: Thermal and barrier properties of poly(butylene adipate-co-terephthalate) incorporated with zeolite doped potassium ion for packaging film

Poonsub Threepopnatkul[1,], Kamonchanok Wongsuton[1], Chonlada Jaiaue[1], Nattanan Rakkietwinai[1], Chanin Kulsetthanchalee[2]*
[1]Silpakorn University; [2]Suan Dusit University, Thailand

P-24: Study of rubber composites between natural rubber and Mahogany Shell Powder (MHSP) and potential for pavement block

*Jedtarin Jaroenta, Rattanawadee Siangsawad, Rittikrai Onkate, Varakorn Jearjiratikul, Chanchai Thongpin**
Silpakorn University, Thailand

P-25: Mechanisms of high grade nitrogen doped graphene synthesis from 5-member ring materials

Yukihiro Muta[1,3], *Nagahiro Saito*[1,2,3,4,*]
[1]*Nagoya University;* [2]*Shinshu University;* [3]*Open Innovation Platform with Enterprises, Research Institute and Academia (OPERA);* [4]*Strategic International Collaborative Research Program (SICORP), Japan*

P-26: Effect of indium on conductivity and photosensitivity of zinc oxide nanoflowers

Papaorn Siribunbandal[1,*], *Tanakorn Osotchan*[2], *Rawat Jaisutti*[1]
[1]*Thammasat University;* [2]*Mahidol University, Thailand*

P-27: A new synthesis route to prepare amphiphilic Pt/C catalyst for highly efficient proton exchange membrane fuel cell

Mongkol Tipplook[1], *Nagahiro Saito*[1,2,3,4,*]
[1] *Nagoya University;* [2]*Shinshu University;* [3]*Open Innovation Platform with Enterprises Research Institute and Academia (OPERA);* [4]*Strategic International Collaborative Research Program (SICORP), Japan*

P-28: Hydrothermal carbonization synthesis and KOH activation of porous carbons from waste marigold flowers

Nattapat Chaiammart[1], *Apiluck Eiad-ua*[2], *Gasidit Panomsuwan*[1,*]
[1]*Kasetsart University;* [2]*King Mongkut Institute of Technology Ladkrabang, Thailand*

P-29: Biodegradable poly(butylene adipate-co-terephthalate)/wheat gluten blends: Effect of PBAT modification on morphological, mechanical and water adsorption properties

Sudsiri Hemsri, Kanjanaporn Saraphat, Rattanawadee Phaorung, Umar Saengsuk, Silpakorn University, Thailand*

P-30: Electrical and mechanical properties of PEDOT:PSS strain sensor based microwave plasma modified prevulcanized rubber surface

Kittiphong Thana[1], *Nattasamon Petchsang*[2], *Rawat Jaisutti*[1,*]
[1]*Thammasat University;* [2] *Kasetsart University, Thailand*

P-31: Effect of isopropyl alcohol on silver nanowire networks for transparent thin film heater

Naraporn Indarit[1], *Nattasamon Petchsang*[2], *Rawat Jaisutti*[1,*]
[1]*Thammasat University;* [2]*Kasetsart University, Thailand*

P-32: Influence of ethylene glycol treatment on conductivity and stability of PEDOT:PSS coated cotton yarn

Kuntima Pattanarat[1], *Nattasamon Petchsang*[2], *Rawat Jaisutti*[1,*]
[1]*Thammasat University;* [2]*Kasetsart University, Thailand*

P-33: Method development for determination of brominated flame retardants in high-impact polystyrene using X-ray fluorescence spectrometry

Polwat Singhasemanont[1,2,*], *Apichat Imyim*[1]
[1]*Chulalongkorn University;* [2]*IRPC Public Company Limited, Thailand*

P-34: Performance of lightweight cement board using coconut coir fiber and expanded polystyrene foam waste

Chanintorn Pusri[1], *Bussarin Ksapabutr*[1,2], *Nattawut Chaiyut*[1], *Manop Panapoy*[1,2,*]
[1]*Silpakorn University;* [2]*Chulalongkorn University, Thailand*

P-35: Efficient removal of methylene blue by low-cost and biodegradable highly effective adsorbents based on biomass in the fixed bed column

Dilok Sasaengt [1], *Manop Panapoy*[1,2], *Nattawut Chaiyut*[1], *Bussarin Ksapabutr*[1,2,*]
[1] *Silpakorn University;* [2] *Chulalongkorn University, Thailand*

P-36: Enhanced mechanical performance of cement board composite reinforced with coconut coir fiber and tire rubber waste

Chalermporn Thepthong[1], *Bussarin Ksapabutr*[1,2], *Nattawut Chaiyut*[1], *Manop Panapoy*[1,2,*]
[1]*Silpakorn University;* [2]*Chulalongkorn University, Thailand*

P-37: One-pot synthesis of cationic nitrogen-doped graphene

Sangwoo Chae[1,3], *Gasidit Panomsuwan*[5] *Nagahiro Saito*[1,2,3,4,*]
[1]*Nagoya University;* [2]*Shinshu University;* [3]*Open Innovation Platform with Enterprises Research Institute and Academia (OPERA);* [4]*Strategic International Collaborative Research Program (SICORP), Japan;* [5]*Kasetsart University, Thailand*

P-38: Synthesis and mechanical properties of NR/EPDM for floor mat

*Khrongkhawn Yoskuna, Rungsima Chollakup, Sirikanjana Thongmee**
Kasetsart University, Thailand

P-39: Synthesis of carbon dots from the biomass product for supercapacitor applications

*Ananya Tibodee, Weekit Sirisaksorn**
Kasetsart University, Thailand

P-40: Design and Develop Rubber Sculpting for Stop Motion Animation

*Vizit Janma, Chor WayakronPhetphaisit**
Nareasuan University, Thailand

P-41: A 3DRISM study of water and potassium ion adsorption in Montmorillonite nanoclay

Nirun Ruankaew[1], *Andika Kristinawati*[1,2], *Norio Yoshida*[3], *Saree Phongphanphanee*[1,*]
[1]*Kasetsart University, Thailand;* [2]*Institut Pertanian Bogor, Indonesia;* [3]*Kyushu University, Japan*

Series seminars on Biomaterials: sustainable research and innovation: 18th December 2019 (All participants are invited without additional fees) at 341 room SC45 Building Kasetsart University, Bangkok, Thailand

18th December 2019

09.00-16.30

Speaker 1: Youli Li, University of California at Santa Barbara, USA

Topic 1: Small angle x-ray scattering: fundamental concepts and applications in probing the nanostructure of biomolecular self-assemblies

Speaker 2: Arkadiusz Chworos, Polish Academy of Sciences, Poland

Topic 2: Biomaterials, their structure, function and applications

Speaker 3: Karine MOUGIN, Institute de Science des Materiaux de Mulhouse, France

Topic 3: Design of gold hierarchically ordered crystals architectures for electrochemical detection of traces of molecules

Speaker 4: Darshil U. Shah, University of Cambridge, England

Topic 4: Working with nature: Designing a structural biocomposite

Note: Coffee Break: 10.30-10.45 and 15.00-15.15
Lunch Time: 12.00-13.30

PLENARY LECTURE

Design of polymer-derived nanoparticles, nanorods, and porous microparticles

Sadhan C. Jana

Department of Polymer Engineering, University of Akron
Akron, OH 44325, USA

A number of applications benefit from nanoparticles, nanorods, and porous microparticles, such as those encountered in catalysis, drug delivery, anticorrosion coatings, or cleaning of noxious chemicals. This talk will focus on synthesis strategies for obtaining large quantities of such functional materials from polymer sources. In the first example, a set of new nanoparticles are synthesized at room temperature by combining two oppositely charged non-toxic biopolymer polyelectrolytes in the form of chitosan and lignosulfonate. The influence of factors, such as the intensity of mixing, total solid content, and the reactant ratio on the nanoparticle size, composition, and porosity is investigated using a turbidimeter, dynamic light scattering method, and zeta potential values. A dense hydrophobic core surrounded by a positively charged hydrophilic shell is proposed as a possible structure of the nanoparticles. The interactions between chitosan and lignosulfonate are predominantly governed by the electrostatic forces with a minor role played by hydrogen bonding. The particle size and porosity are seen to increase with an increase of the total solid content while the number of particles is determined from the ratio of the two reactants. The second example discusses fabrication of highly porous polyimide aerogel microparticles and microrods of diameter 200-1000 μm from a surfactant-free, two-phase, silicone oil/dimethylformamide (DMF) oil-in-oil (O/O) system using a simple microfluidic device. The polyimide sol prepared in DMF is turned into droplets suspended in silicone oil in the microfluidic device. The droplets are guided to a heated silicone oil bath to accelerate sol-gel transition and imidization reactions, thereby yielding spherical, discrete gel microparticles that do not undergo coalescence. The discrete gel microparticles are isolated and supercritically dried to obtain aerogel microparticles. The microparticle size distribution shows dependence on dispersed and continuous phase flowrates in the microfluidic channels. The microparticle surface morphology shows dependence on silicone oil bath temperature. The results are discussed in light of existing literature work on fabrication of solid microparticles, mesoporous microparticles, leading finally to a novel microfluidic process for continuous manufacturing of core-shell microparticles with mesoporous shell materials. Such particles find applications in absorption of noxious liquids and as hosts for catalysts. The principles from the above examples will be summarized in the form of guidelines.

Nanomechanisms of plastic deformations of polymers

Andrzej Galeski

Centre of Molecular and Macromolecular Studies, Polish Academy of Sciences, 90-363 Lodz, Poland
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Plastic deformation of amorphous polymers is the most peculiar among all materials. The plasticity is achieved by a series of crack-like events in a micrometer range, called crazes, which are, however, span by nanofibrils that are transmitting the stress and preventing for fracture.

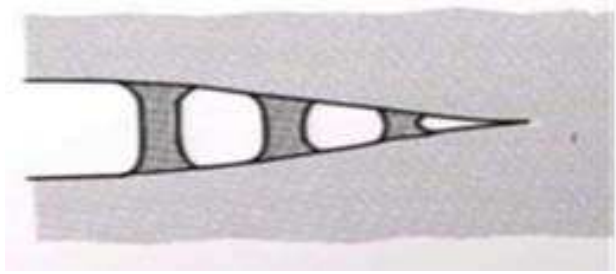


Fig 1. Nanofibrils, called tufts, are composed of bundles of highly elongated macromolecules.

The other important mechanisms of plastic deformation of a polymer is by shear banding, a strongly localized deformation in planes tilted at 45^{o} with respect to the tensile or compression force.

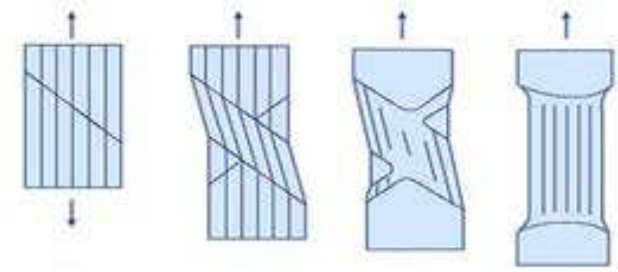


Fig 2. Development of high orientation by progressive shear banding in tensile deformation.

Often non-homogeneous deformation is caused by co-existence of both forms. Those two mechanisms are not excluding each other. Most of commodity polymers are crystalline materials with unique structure of lamellar crystals arranged parallel in stacks with alternating amorphous layers, both entities having thickness in a nanometer range. It is in the interlamellar regions that the initial stage of deformation takes place. It follows that stress required to initiate deformation of amorphous phase constitutes from 2 to 10% of the stress needed to activate the mechanisms of crystalline phase deformation. However, yielding concerns exclusively the polymer crystals and it sets in when the stress exceeds yield stress. Mechanism for yielding of semicrystalline polymers consists of emission of dislocations from the edges of the lamellae across the narrow faces and their travel across crystals via crystallographic slips.

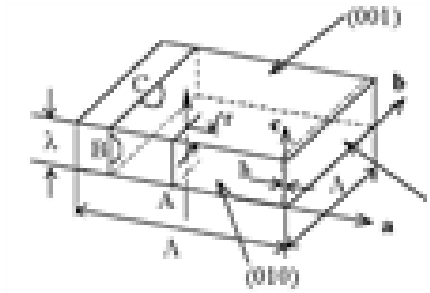


Fig 3. Types of dislocations generated at polyethylene lamellar crystals: A monolithic screw, B screw half loop, and C edge half loop [1].

The crystal thickness is then a crucial parameter for monolithic screw while not for half loops. Dislocation theory predicts the correct order of magnitude of the yield stress that agrees best for the Burgers vector of dislocations for various polymer crystals. However, there are experimental evidences that the yield stress of semicrystalline polymers depends not only on crystal thickness but also on the degree of crystallinity. Recently [2, 3] it was shown that plastic yielding of semicrystalline polymers is greatly affected by the state of their amorphous phase. Changes made to the amorphous phase such as addition of low molecular fraction, swelling, additional entanglements, which does not affect crystalline phase, causes deformation of lamellae stacks, however, there is no expansion of stacks along lamellae basal planes while stretched chains of amorphous phase generate uniaxial tension transmitted to lamellae surfaces. It appears that measured yield stress plus the stress exerted by amorphous phase amounts exactly to the stress required for plastic deformation of crystals, therefore the yielding is determined by the same crystal plasticity despite different external load. The changes to amorphous phase

may account to the explanation why yielding depends on crystallinity degree. It appeared that one of the main nanomechanisms of plastic deformation of crystalline polymers is cavitation during stretching. Cavitation nanopores are formed within amorphous interlamellar layers having initially the size less or equal to layer thickness (5-20 nm). They grow during stretching, finally contributing to as much as 20-100% of the initial material volume. The detailed studies [3, 4] indicated that the cavitation nanopores are initiated and formed from free volume pores of the amorphous phase.

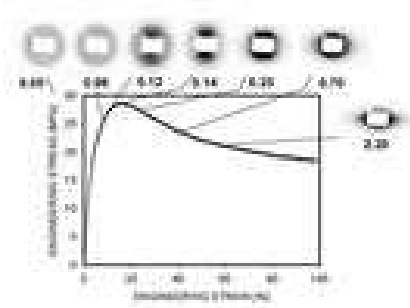
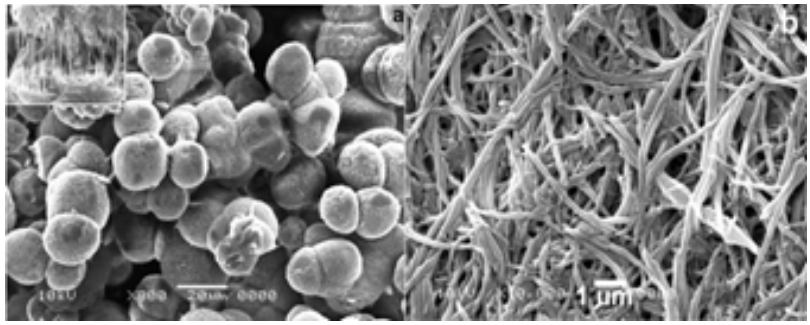


Figure 4. Cavitation seen as stress whitening, is also observed in SAXS (small angle X-ray scattering). Strong SAXS scattering appear around the yielding during stretching of polyethylene [5]. SAXS patterns recorded *in situ* at Hamburg synchrotron facilities.

Plastic deformation of polymers is strongly impeded by entanglement of macromolecules. Free drawing is restricted by strain hardening and fracture resulted from stretching of entanglement network. There are ways of preparation of crystalline polymers devoid of most of entanglement knots. Such crystalline polymer can be easily drawn via dislocation-crystallographic slips to very high deformation ratio. The plastic flow can be so easy that grains of disentangled polymer embedded in another viscous media can be deformed into nanofibrils by melt shearing.



Figures 5. SEM images of grains of disentangled polypropylene and of nanofibrils after shear deformation during compounding of disentangled polypropylene grains with polystyrene [6]. Polystyrene matrix was removed by dissolution in toluene.

There are several independent nanomechanisms of plastic deformation of polymers: crazing, shear bands, crystallographic slips and cavitation. Entanglement of macromolecules, its density can be controlled and then it influences all elementary mechanisms of plastic deformation. By intensifying or restricting those mechanisms we obtain new materials with new properties.

References

[1] A.S. Argon, A. Galeski, T. Kazmierczak, *Rate mechanisms of plasticity in semi-crystalline polyethylene*. Polymer, 2005, **46**, 11798-11805.

[2] A. Rozanski, A. Galeski, *Controlling cavitation of semicrystalline polymers during tensile drawing.* Macromolecules, 2011, **44**, 7273-7287.

[3] A. Rozanski, A. Galeski, M. Debowska. *Initiation of Cavitation of Polypropylene during Tensile Drawing*. Macromolecules, 2011, **44**, 20-28

[4] A. Pawlak, A. Galeski, A. Rozanski, *Cavitation during deformation of semicrystalline polymers*. Prog.Polym.Sci., 2014, **39**, 921-958

[5] A.Pawlak, A. Galeski, *Cavitation during tensile drawing of annealed high density polyethylene.* Polymer, 2010, **51**, 5771-5779

[6] J. Krajenta, A. Pawlak, A. Galeski, *Deformation of Disentangled Polypropylene Crystalline Grains into Nanofibers*. J.Polym.Sci., Part B Polym.Phys. 2016, **54**, 1983-1994

[7] A.Pawlak, J.Krajenta, A.Galeski *Cavitation phenomenon and mechanical properties of partially disentangled polypropylene.* Polymer, 2018, 151, 15-26

Exploring life phenomena woven by water and biomolecules

Fumio Hirata

Toyota Physical and Chemical Research Institute & Institute for Molecular Science

In a living body, a variety of molecules are working in concerted manner to maintain their life, and to inherit the genetic information from generation to generation. In that respect, life embodies two aspects, one as molecules (or *matter*) and the other as *information*. Needless to say, protein, RNA, and DNA are among the main players of the *life theater*. However, those so called the *biomolecules* by themselves cannot play their intrinsic roles without *water*, or may not even exist in the universe. Let us see this by taking an enzymatic reaction as an example, which is a protein to catalyze a chemical reaction. Firstly, an enzyme should take a specific structure referred to as "native conformation" to be able to work as a catalyst, which has a cavity to accommodate substrate molecules of the reaction. Without water, a protein cannot take such a specific structure. Secondly, an enzyme should bind and/or unbind substrate molecules at the cavity or active site. The process, called *molecular recognition*, is controlled by *hydration* and *dehydration* processes. Thirdly, the both processes are regulated by another physicochemical process referred to as *structural fluctuation* that in turn is governed by the hydration free energy. And, finally, a water molecule itself becomes a substrate of a chemical reaction called *hydrolysis* that is the most abundant reactions taking place in our body. So, life phenomena are *woven* by water as *warp* and biomolecules as *woof*.
The speaker has been exploring such phenomena for more than thirty years based on the statistical mechanics of molecular liquids, or the RISM and 3D-RISM theories. In the main part of his talk, the speaker will present his latest works that are related to the structural fluctuation of protein, driven by *water*. He will also mension possible applications of the theory to the material science, such as the solid-state ion battery.

References

[1] F. Hirata, ed. *Molecular Theory of Solvation*, Kluwers, 2003.
[2] Yoshida et al., *J. Phys. Chem.*,
[3] F. Hirata, *Exploring Life Phenomena with Statistical Mechanics of Molecular Liquids*, CRC, 2019.

INVITED LECTURE

Research and development to reduce the weights of solid tyres

Krisda Suchiva*, Chakrit Sirisinha, and Sira Meesaringkarn

Rubber Technology Research Centre, Faculty of Science,
Mahidol University, Nakhon Pathom 73170, Thailand
*Corresponding author: krisda.suc@mahidol.ac.th

The Research and Development of Solid Tyres Project was carried out in order to support the development of the Thai solid tyres industry, which consumes about 30,000 tonnes/year of natural rubber and generates income from export of about 2,000 million baht/year. The objective of the project is to develop lighter weight solid tyre by collaborating with V.S.Rubber Industry Co., Ltd. The computer-aided design (CAD) and computer-aided engineering (CAE) technologies were used to develop lighter weight tyre. Finite element method (FEM) was employed to analyse stress distribution in solid tyre model. Study was made to lower the weight of a model of solid tyre of V.S.Rubber Industry Co., Ltd. comparing with 6 other solid tyres in the market. Figure 1 shows how the weight of the original solid tyre was reduced. Lighter weight solid tyre prototypes were made which showed weight reduction of 2.42 kg. or 9.26 % for solid tyre model 6.00-9 (back wheel tyre) and 4.05 kg. or 8.69 % for solid tyre model 7.00-12 (front wheel tyre). Endurance tests of the reduced weight solid tyres (Table 1) showed that they passed the Thai Industrial Standard Institute (TISI) standards and were superior to the performance of the original solid tyres by 22.0 % and 34.5 % for the tyre sizes 6.00-9 (back tyre) and 7.00-12 (front tyre) respectively.

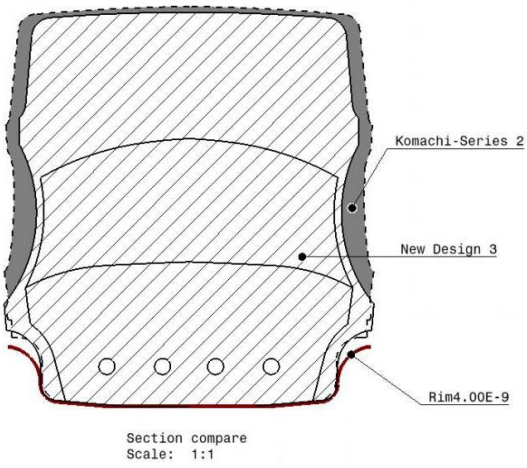


Fig. 1. Diagram shows how the weight of the New design was reduced.

Table 1 Endurance test results of the original and newly designed reduced weight solid tyres

Tyre size	**6.00-9**	**7.00-12**
Testing time until first damage according to TISI standards (minutes)		
Komachi Series 2	118	119
New design 3	144	160
% Differences	22.0	34.5

The development of radiation shielding products from natural rubber

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In the past decade radiation, like neutron or gamma ray, are widely used in various applications and activities such as in laboratories, industries or hospitals. Exposure to radiation could potentially yield a significant health hazard; therefore, the development of radiation protection materials is crucially needed [1]. For this propose, radiation shielding substances such as boron oxide, tungsten trioxide, lead oxide, barium oxide or bismuth trioxide were added into natural rubber compound before product forming process [2]. In this study, many rubber products were developed as radiation shielding protections including shielding block, glove, protective apron and thyroid. The results reveal that all products made from natural rubber showed a desirable shielding performance. However, the higher the fraction of shielding substance in natural rubber products, the lower the mechanical properties of the products. Therefore, the optimum point between shielding capacity and mechanical properties of the product is taken into considerations. In addition, it was found that the uniform dispersion of radiation shielding substances in the rubber texture can be obtained in all shielding products.

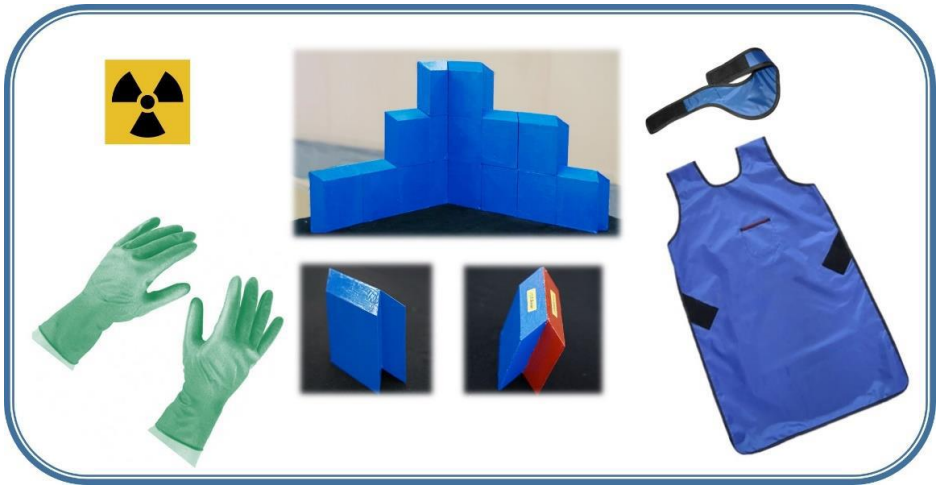

Fig. 1. Radiation shielding products from natural rubber

References

[1] Price BT, Horten CC and Spinnery KT 1957 Radiation Shielding (Elmsford, New York: Pergamon).
[1] El-Khatib A, Kassem M and Ezzat AA 1990 J. Polym. Mater.

Non-Silane coupling agents for silica reinforcement of rubber

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Elastomers are inherently weak and must be reinforced by particulate fillers for most practical applications. Carbon black and silica are the most common and effective reinforcing fillers. In particular for the tire industry, silica potentially provides certain advantages, including low rolling resistance, reduced abrasive wear, and improved wet-skid resistance in comparison to carbon black. These advantages are only realized when the silica filler is mixed with rubber in the presence of bifunctional silane coupling agents, which covalently modify the surface of silica particles and form covalent linkages with the rubber during mixing and/or vulcanization. The presentation will explore the possibility of using catechol derivatives to replace the silane coupling agents [1,2]. In particular, a natural derivative of catechol, urushiol, is used as the raw material to prepare the catechol-based surface-modified agents. We will show that the catechol-based non-silane coupling agents are equal or superior to silane coupling agents such as TESPT as dispersion aid. However, the current non-silane coupling agents cannot form sufficient covalent bonds with the rubber chains. When a combination of the catechol-based coupling agent and TESPT are used, the resulting SBR vulcanizates show an overall improvement of their mechanical and dynamic mechanical properties. Finally, the replacement of the silane coupling agents with catechol-based coupling agents has an obvious environmental benefit, i.e., no ethanol is released into the atmosphere a rubber-mixing byproduct.

References

[1] Yan, X.; Hamed, G. R.; * Jia, L.* "Urushio-derived non-silane coupling agent", *Polymer* **2017**, *125*, 172-181.

[2] Yan, X.; Hamed, G. R.; Jia, L.* "Modulating silica-rubber interface by a biorenewable urushiol derivative. Synthesis, surface modification, and mechanical and dynamic mechanical propteretes of vulcanizates therefrom", J. Appl. *Polym. Sci.* **2018**, *DOI: 10.1002/app.45937*.

Enhancement of the compatibility between natural rubber and pineapple leaf microfibers for better stress transfer in their composite

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The compatibility between natural rubber (NR) and pineapple leaf microfibers (PALMF) in NR-PALMF composites were improved by two methods. One method was carried out by the addition of nitrile rubber (NBR) during mixing [1]. The other method was by chemically treating PALMF surface with silane and/or a compatibilizer. Modulus at low strain of NR-PALMF composites increased in both cases. Composite prepared with silane modified PALMF has however higher modulus than that containing NBR indicating better compatibility between NR and PALMF. Modulus at high strain of NR-PALMF composites has also been increased by addition of carbon black filler. This system has been compared to natural rubber reinforced by aramid fibers (Fig 1.) and has shown better mechanical properties

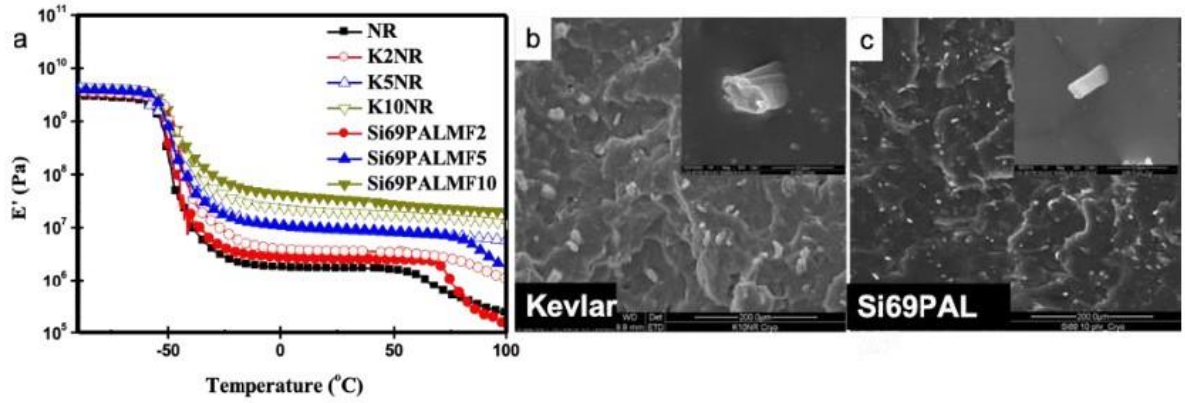

Fig. 1. Elastic moduli (E') of aramid and pineapple leaf microfiber composites made of natural rubber (b) SEM micrographs of cryogenic fractured natural rubber composites at low and high magnifications for b) aramid composite, c) PALMF treated composite.

References

[1] Hariwongsanupab, N., Thanawan, S., Amornsakchai, T., Vallat, M-F., Mougin K., Polymer Testing. 57, 94-100 (2017)

Development of a manual for rubber plantation owners and rubber wood consumers in Thailand for obtaining international forest management certification

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Currently, the export situation of rubber wood products in Thailand is at a high risk of price and market competition. All relevant organizations in Thailand hope to solve these problems sustainably. One of the important ways is to increase the value of rubber wood products and marketing channels for exporting to more countries besides China. However, Thailand still faces a significant obstacle to the export of rubber wood products, that is, most of the rubber plantations have not yet been certified for international forest management. Forest certification is one mechanism to prevent and manage global environmental problems including air, soil, water, biodiversity and the reduction of forest areas. Previous research [1] indicated that most rubber plantation owners and rubber wood consumers in Thailand did not fully understand the principles, criteria, and indicators of the Forest Stewardship Council (FSC), and that in Forest Management (FM) certification auditors need to process a request for Corrective Action Requests (CARs) or suspend certificates in some cases. Therefore, this research aimed to develop an appropriate manual for rubber plantation owners and rubber wood consumers in Thailand for obtaining the FSC standards. Secondary data of the forest management certification system at the international level, including organizations, certification process, and FSC certification standards, were analysed and related to data at the national level (i.e., laws, regulations and status of rubber plantations in economic, social and environmental dimensions). The consistency and limitations of FSC principles, criteria, and indicators in certificates issued in Thailand were also analysed. A manual, with recommendations for compliance with FSC standard, was developed. It consists of five chapters: 1) FSC definition; 2) FSC scoping; 3) FSC evaluation and surveillance; 4) FSC scoping assessment; and 5) implementations in accordance with FSC standards. This knowledge had been shared through workshops with the rubber plantation owners, rubber wood consumers, staff of the Rubber Authority of Thailand, and other organizations. In total, over 150 people attended the workshops in the following locations: Songkla, Surat Thani, Rayong, and Bangkok. The workshops aimed to develop the participant skills to request for FSC: FM certification.

Eco-friendly wall materials produced from forestry wastes and natural binder

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In Thailand, teak forests are more than nine hundred thousand acres. Burning, which create air pollution problems, is one of the methods usually used to get rid of the enormous teak leaves falling during the shedding of each year. To reduce this problem and to add values to the teak leave wastes, development of the chemical free sound insulation materials with good quality of low thermal conductivity for interior walls, which were produced from teak leave wastes together with the use of "Yang Bong" (Persea Kurzii Kosterm) as natural binder was proposed [1] [2]. The ongoing research from the previous research is in progress and will be presented.

Fig. 1. Teak leaves sound insulation material for interior walls.

References

[1] P. Klinrod, S. Visitsak, J. Khedari, and S. Jarusombuti, Interior panels produced from teak leaves, *Proc. Int. Conf. on Sustainable Energy and Green Architecture (SEGA-04)*, March, 210-214 (2015).
[2] P. Klinrod, Interior panels produced from teak leaves, *Master's Thesis,* Graduate School of Architecture, Kasetsart University, (2015).

Synthesis of nanosale photoenergy conversion materials –from biomarkers to afterglow devices–

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Nanoscale materials, such as nanoparticles, nanorods, and nanowires serve as useful devices in terms of photoenergy conversion. In particular, photoenergy conversion is achieved in terms of the energy difference between input and output wavelengths of light, where down conversion is employed in our present work. Notably, upconversion is still relatively low in efficiency (<3%). We have prepared rare-earth nanoparticles and rare-earth complexes as photoenergy conversion materials [1,2] having optical absorption band ranging in UV to visible regions, and dispersed these materials into organogel [3,4] environments. Metal nanoparticles with emission, in the visible region on the other hand, are proven to show useful functions in softmaterials. We therefore disperse these nanoparticles into agricultural crops, where mutual interactions between particles and vessels or sieve tubes are important in termns of particles delivery. Crop sections are processed with optical microscopy, using excitation light, which serves as a potential application to optical biomarkers if the particle surfaces are modified appropriately. At the conference, I will talk about photoenergy conversion in the nanoscale and recent results on interaction between metal-oxide nanoparticles and poaceous or cucurbitaceous crops.

References

[1] Y. Akita, T. Harada, R. Sasai, K. Tomita, K. Nishiyama, Emission Properties of Ln (Eu, Tb, Dy, Er)-Doped Y_2O_3 Nanoparticles Synthesized by Surfactant-Assembly and Their Applications in Visible Color-Tuning, *J. Photochem. Photobiol. A* 2015, 299, 87–93.

[2] Y. Akita, T. Harada, R. Sasai, K. Tomita, K. Nishiyama, Possible Size Control and Emission Characteristics of Eu^{3+}–Doped Y_2O_3 Nanoparticles Synthesized by Surfactant-Assembly, *Chem. Phys. Lett.* 2016, 659, 121–125.

[3] S. Katsube, M. Kinoshita, K. Amano, T. Sato, Y. Katsumoto, T. Umecky, T. Takamuku, T. Kaji, M. Hiramoto, Y. Tsurunaga, K. Nishiyama, Solvent-Dependent Properties and Higher-Order Structures of Aryl Alcohol + Surfactant Molecular Gels, *Langmuir* 32 (2016) 4352−4360.

[4] K. Nishiyama, M. Kinoshita, T. Harada, Y. Katsumoto, Synthesis of optically clear molecular organogels using phenol and a sulfosuccinic surfactant in various solvents with cyclic geometries, *J. Mol. Liq.* 268 (2018) 685–690.

Hybrid materials for hand-held pesticide detection

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Pesticides are widely used in producing fruits and vegetables to control pests and can be safe if handled properly. However, in Thailand, there is still a dispute regarding pesticides that should be allowed. Moreover, prohibited pesticides have been found in use. Attempts to understand hybrid materials and fabricate devices for hand-held pesticide detection will be demonstrated. As examples, mesocellular foam silica (MCF) and gold nanoparticles (AuNPs) have been studied to modify amperometric biosensors and organic field effect transistors (OFET) for pesticide detection. Together with electrochemical and transistor characterization, materials characterization techniques such as TGA, XRD, SEM, TEM, FTIR, SIMS and Nitrogen adsorption have enabled optimized conditions of the hybrid materials. Fig. 1 shows morphologies of optimized (a) MCF and (b) MCF:AuNPs composites, respectively. The hybrid materials were immobilized with enzyme acetylcholinesterase (AChE), modified on screenprinted carbon electrodes and tested for electrochemical responses with acetylthiocholine [1]. For OFET, MCF modified water-gated OFETs were fabricated in order to detect Chlorpyrifos pesticide in water [2].

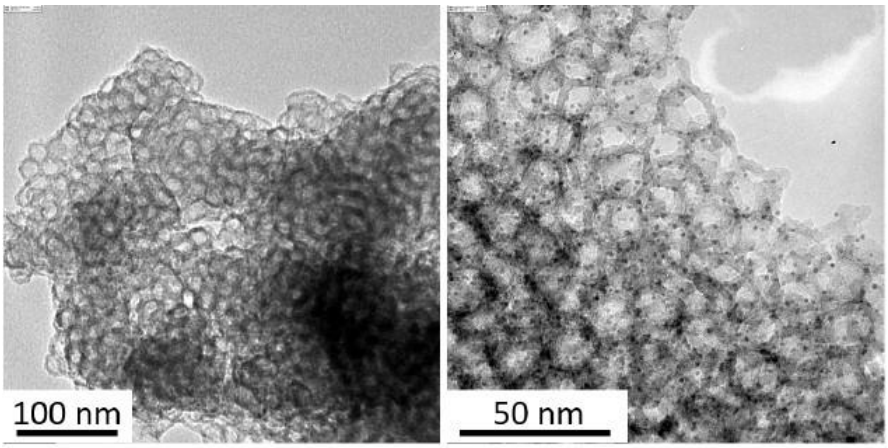

Fig. 1. TEM micrographs showing (a) MCF and (b) MCF:AuNPs [1].

References

[1] N. Thananukul, A. Phongphut, S. Prichanont, C. Thanachayanont, S. Fearn and B. Chayasombat, Journal of Porous Materials 26 (2019) 1059-1068.
[2] K. Inpor, N. Houngkanhang, S. Pratontep, N. Thananukool, S. Prichanont, B. Chayasombat and C.Thanachayanont, J. Nanoelectronics and Optoelectronics, 11 (2016) 1-4.

Development of multiscale method for nano-bio materials design based on statistical mechanics theory of molecular liquids

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The solvent plays an essential role to determine the structure, properties, and function of the material in solution phase. The three-dimensional reference interaction site model (3D-RISM) theory is one of the most powerful tools to investigate such processes in solution [1]. Recently, we have developed the multiscale modeling software based on the 3D-RISM called the reference interaction site-model integrated calculator (RISMiCal). The electronic structural changes of materials are one of the most serious concern in materials design. We proposed an efficient implementation of 3D-RISM to the electronic-structure theory of macromolecules such as fragment molecular orbital (FMO) and quantum mechanics/molecular mechanics (QM/MM) methods. These methods are referred to as FMO/3D-RISM and QM/MM/RISM, respectively (Figure 1) [2]. They allow us to treat an electronic structure of macromolecules, such as protein, as well as a solvent distribution around the solute macromolecules. The solvent polarization induced by solute electrostatic potential is also important feature for material design. For example, the electron transfer rate in solution is strongly affected by the solvent polarizability. Recently, we have proposed new method to handle the solvent polarization in the 3D-RISM framework, which is called the solvent-polarizable 3D-RISM theory [3]. In this talk, the basics of the 3D-RISM theory and the developments of the advanced methods based on the 3D-RISM theory stated above are reviewed.

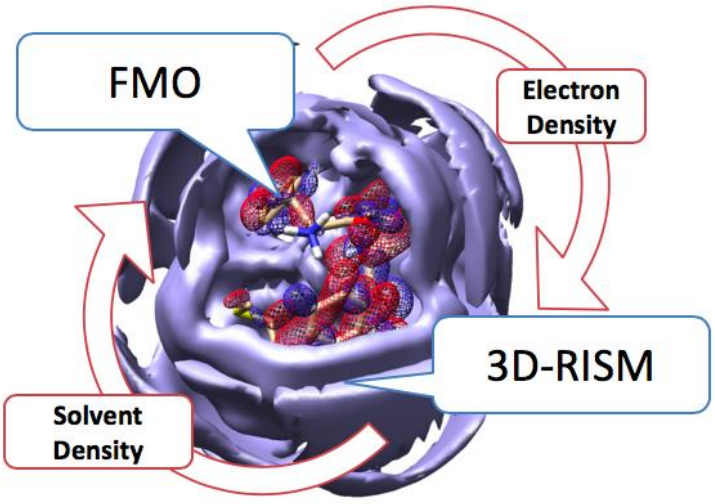

Fig. 1. Multiscale implementation of 3D-RISM

References
[1] N. Yoshida, *J. Chem. Info. Model* 57, 2646 (2017).
[2] N. Yoshida, *J. Chem. Phys.* 140, 214118 (2014)
[3] N. Yoshida and T. Yamaguchi, In preparation.

Statistical mechanics study of separation of inert solvent mixtures by a porous material

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Distillation is a method to separate a mixture which has many kinds of non-polar molecules. The huge plants are important still now because they give us purified liquids from a mixture, such as crude petroleum. In this talk, we want to discuss an alternative method to separate a liquid mixture by using a confined space. This study is promoted by experiments that are started by the first author of this presentation [1]. However, we will discuss this subject from the theoretical aspect, especially entropic attraction caused by solvent molecules. One of the most simple ideas of entropic attraction was given by Asakura and Oosawa in 1954[2]. Figure 1 shows the concept of Asakura-Oosawa theory under isochoric condition. The effective interaction between large molecules is discussed. When the small particles cannot penetrate the large molecules, the small molecules are excluded by the large molecules. The excluded volume is the inside of the dotted lines that surround the large molecules. Here the total excluded volume for Fig. 1b is smaller than that for Fig. 1a because the volumes excluded by two large particles overlap. Therefore, the configurational space for the small sphere in Fig.1b is larger and the entropy is larger than that in Fig. 1a. So, the contact dimer is more stable than the separated large spheres. As a result, the entropic attraction appears between large spheres.

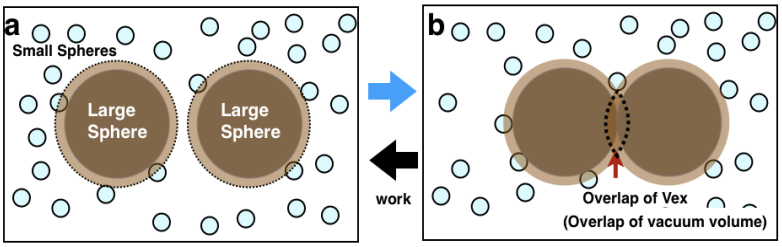

Fig.1: Small spheres cannot penetrate the large spheres. The inner spaces of dotted circles are excluded volume. The configurational space for the small spheres is outside of the circles.

As the overlap volume increases, the stability becomes larger. It means that the adsorption stability on a hard surface for large spheres is larger than that for small spheres. The differences are enhanced by the shape of the surface. When the shape of the surface is concave or cave-like, the large spheres are selectively absorbed in the cave (Figure 2). Some polymer crystals have those cave. The selective absorption is observed when the polyolefin crystal is immersed in the binary mixture of alkanes. In the experiment, it is difficult to assume the specific direct attraction between the cave and the absorbed alkane.

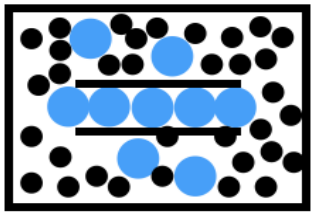

Fig.2: A hard tube shows selective absorption of large spheres.

In this presentation, the results calculated by using an integral equation theory are shown and they are compared with the experimental results. Those comparisons are discussed on the basis of excluded volume idea, namely the Asakura-Oosawa theory.

References

[1] A. Chiba, A. Oshima, R. Akiyama, Langmuir, accepted (2019).
[2] S. Asakura, F. Oosawa, J. Chem. Phys. 22, 1255 (1954).

Relation between mesostructure and viscoelasticity of ionic liquids

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Room-temperature ionic liquids (RTILs) are liquid materials composed solely of ions, which have been studied for more than a decade owing to their potential applications such as electrolytes of electrochemical devices, reaction media, and so on. Shear viscosity is one of the important physicochemical properties for such applications. On the other hand, RTILs with a long alkyl chain have been studied from fundamental viewpoints due to their peculiar mesostructure composed of polar and nonpolar domains. Therefore, it is of both scientific and industrial importance how the mesostructure of RTIL is related to shear viscosity. In this presentation, we would like to review our series of studies on this issue by means of mode-coupling theory (MCT), viscoelastic spectroscopy and molecular dynamics (MD) simulation.
In the MCT part [1], we applied the MCT based on interaction-site model to the model ionic liquid proposed by Perera and Mazighi [2] that can control the degree of the mesostructure systematically. The site-site static structure factor calculated by the integral equation theory was employed as the input function of MCT, and the shear viscosity was calculated based on the Kubo-Green formula. The theory demonstrated that there are two different ways in which the mesostructure increases shear viscosity. The first one is the direct coupling between the mesostructure and shear stress, which is represented as the viscoelastic relaxation as slow as the dynamics of the domain structure. The second one is that the presence of the domain structure retards the dynamics of the charge-alternation mode, which retards the relaxation of the shear stress through its coupling with the charge-alternation mode. In the experimental part [3,4], the frequency-dependent complex shear viscosity of some RTILs were measured in the MHz region by means of shear impedance spectroscopy, and the viscoelastic spectra were compared with the structural relaxations of both domain and charge-alternation modes determined by neutron spin-echo (NSE) spectroscopy. The relaxation frequency of the complex viscosity lies between those of the domain and the charge-alternation modes. In particular, the relaxation of the shear stress is faster than that predicted from that of the mesostructure, suggesting that the shear viscosity of RTIL is not dominated by the dynamics of the domain structure under conditions we have investigated. In the MD simulation part [5], the time-dependent cross correlation function between the two-body density and the shear stress was evaluated. The cross correlations with the anisotropic shifts of both the domain and the charge-alternation modes were found. The relaxation of the cross correlation was as slow as the expectation from the intermediate scattering function. On the other hand, the coupling with the mesostructure was not so evident in the viscoelastic relaxation. It was thus concluded that, although the deformation of the domain structure occurs under shear, its contribution to the shear stress is small.

References

[1] T. Yamaguchi, J. Chem. Phys. 144, 124514 (2016).
[2] A. Perera and R. Mazighi, J. Mol. Liq. 210, 243 (2015).
[3] T. Yamaguchi *et al.*, J. Chem. Phys. 137, 104511 (2012).
[4] T. Yamaguchi, T. Yonezawa and S. Koda, Phys. Chem. Chem. Phys. 17, 19126 (2015).
[5] T. Yamaguchi, Phys. Chem. Chem. Phys. 20, 17809 (2018).

RNA nanostructures for responsive therapeutics

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Nucleic acids, and especially RNA, seems to be a perfect material for responsive therapeutics. DNA/RNA molecules are of the interest for material scientists, due to its intrinsic programmability, biocompatibility, specific recognition potential and predictable folding. one can envision creating responsive RNA based nano-materials, which would be able to target unwanted cells in human organism and mediate the gene expression apparatus. The RNA fragments can be programmed to regulate expression of specific oncogenes via known RNA interference mechanism. Such assemblies have been constructed and successfully applied in model animal studies. Here we will view the methodology leading towards design, synthesis and analysis of structurally stable RNA nano-objects. Multimolecular nano-particles, containing specific RNA fragments targeting selected genes are designed to create structurally stable biomaterials. Controlled folding process ensures stability for entire RNA nano-structure. Such particles, supplemented with delivery agent can be applied in cellular studies in time used for personalized medical therapies. Nucleic acids based nano-structures are getting more attention in the perspective of their use in the medicine.

A swarm molecular robot constructed from photo-sensor, DNA processor and biomolecular motor

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Swarming is a fascinating display of coordinated behavior of living organisms often observed in nature, which explores various emergent functions giving rise to swarm intelligence [1]. Being inspired from nature, study of swarming to attain some artificial swarm intelligence is rapidly growing [2]. Despite several manifestations, mimicking the swarm behavior has been so far challenging due to dearth of scalability and functional robustness of designed swarm units. However, latest technological advancements permit the fabrication of molecules with tunable properties whose group behavior can be regulated [3]. In this work, we used biomolecular motor protein kinesin as swarming molecular actuator, which can propel microtubules (MTs) in an in vitro motility assay [5, 6, 7]. We controlled the swarming of MTs using a highly selective and programmable material DNA to operate the logical operations. To demonstrate swarming of MTs, logic gate operations were applied with input signals as fully complementary DNA (l-DNA) to modifier DNAs followed by tuning the initial conditions. The swarming of the MTs has been manifested through logic operations, which enabled self-assembly of MTs where complementary interaction of DNA changes their color from red and green to yellow (Fig. 1). The swarm pattern was found to be reversible to the single state in response to the input dissociative DNA signal that makes the system reversible logic type. The shape and size of swarm pattern was found to change varying the physical properties of MTs where mode of motion of swarm was tuned from translational to rotational by changing the swarm pattern. The reversibility of swarming pattern was also able to control using photoresponsive azo-DNA which offers construction of switch on-off system. Finally, using high selectivity of DNA molecules and their hybridization property, orthogonal swarming of the DNA-MTs of different patterns was demonstrated which helps to build more complicated system for robotic applications

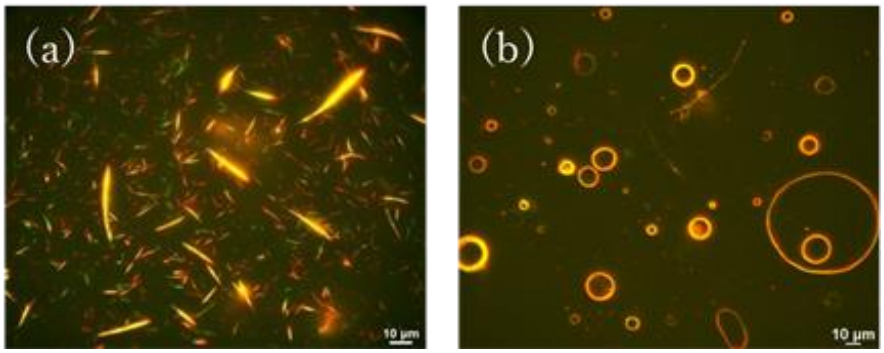

Fig. 1. Different types of swarm behavior (a) bundle and (b) ring shaped structures by DNA equipped biomolecular motor system.

References

[1] E. Bonabeau, M. Dorigo, and G. Theraulaz, Oxford: Oxford University Press; 1999.
[2] M. Rubenstein, A. Cornejo, and R. Nagpal, ***Science***. **345**, 795 (2014).
[3] N. C. Seeman, ***Trends Biotechnol.*** **17**, 437 (1999).
[4] D. Inoue and A. Kakugo ***Nature communications***, 7:12557; (2016)
[5] J. J. Keya and A. Kakugo et al. ***Nature communications***, 9, 453 (2018)
[6] K. Matsuda and A. Kakugo et al. ***Nano Letters***, 19, 6, 3933 (2019)
[7] D. Inoue and A. Kakugo et. al. ***ACS Nano***, doi.org/10.1021/acsnano.9b01450 (2019)

The wonders of Silk: Developing tomorrows advanced biomaterials, foams and composites

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While silks have long been (and incorrectly) hyped for use in ultra-light bullet-proof vests, they have found some niche technical (e.g. high-end tubular tires and 'ballistic boxers') and biomedical (e.g. surgical sutures threads and composite scaffolds for cartilage replacement) applications. Yet, today's silks are still predominantly used in garments and textiles. However, our own most recent studies suggest that nature's wonder-fibre silk can inspire or be transformed into a diverse range of biomaterial forms for wide-ranging engineering applications. In this talk, we will first explore the beauty and biomechanics of silk in its natural forms – both filaments and cocoons. Then, we will discuss silk-inspired biomaterials, such as our invention of a new class of ambient-temperature processable green supramolecular hydrogels and their fibres with unique emerging properties. Thereafter, we will examine silks as a strong natural fibre candidate for reinforcements in polymer composites, in the form of textile laminates, syntactic foams, sandwich-structures, and natural rubber elastomeric composites. Finally, we will touch on smart strain-sensing composite materials with silks, and the life cycle analysis of silks.

Bio based thermoplastic vulcanizates from natural rubber (bioplastic/NR)

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Thermoplastic vulcanizates (TPV) is a class of thermoplastic elastomer of which generally consists of polyolefin phase, mainly PP or PE, with dynamically cured elastomer phase such as EPDM. The elastomer should be well dispersed in the polyolefin matrix which facilitates thermoplastic like processing of elastomer. The properties of TPV are mainly governed by properties of thermoplastic matrix and vulcanized rubber phases including curing system used for dynamic vulcanization. As environmental problem has been an important issue, application of bioplastic in thermoplastic elastomer is an interesting issue. The blending of NR with various has been studied in our work and the system should classify as bioplastics/NR. Dynamic vulcanization of NR during melt blending of NR with various bioplastics was also studied. In this report, the melt blending system of PBAT/NR; PCL/NR and PBS/NR were carried out. The batch melt blending in an internal mixer were performed with various NR and bioplastics compositions. Dynamic vulcanization of NR phase, using Luperox® 101 as curing agent, was also occurred in the mixer during melt blending. Except for PBS/NR TPV system where dicumyl peroxide was used as curing agent. This will advantage for foam preparation in further foaming step. The results showed that PBAT/NR TPV with NR content as high as 70 % possessed tension set less than 20% and elongation at break under tension was higher than 600%. For PCL/NR system at the same composition, the tension set was also found at 20%, elongation at break under tension was as high as 1000%. The TPV system of PBAT/NR and PCL/NR were also extrudable. Tension set for NR/PBS TPV system was found at about 30 % and the elongation at break under tension was about 600%. From the mentioned basic properties of biobased TPV in our researches, it presents that they could propose the promising qualified TPV, in term of reprocess ability and advantage for the sake of biodegradability.

References

[1] K. Naskar. Thermoplastic Elastomers Based on PP/EPDM Blends by Dynamic Vulcanization. Rubber Chemistry and Technology, 80(3), 504–519. (2007).
[2] S. Utara, and P. Boochathum. Novel dynamic vulcanization of polyethylene and ozonolysed natural rubber blends: Effect of curing system and blending ratio. Journal of Applied Polymer Science, 120(5), 2606–2614. (2010).
[3] B. Imre, and B. Pukánszky. Compatibilization in bio-based and biodegradable polymer blends. European Polymer Journal, 49(6), 1215–1233. (2013).

Control of versatile higher-ordered structures of pDNA by block copolymers and their application as gene delivery system

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DNA folding is a core phenomenon in genome packaging within a nucleus. In principle, this is a polyion complexion formed between DNA and polycations. Block catiomers composed of a polycation and a hydrophilic polymer, most typically poly (ethylene glycol) (PEG), allow single-molecule DNA for folding within the spontaneously formed polyplex micellar structure, eventually exhibiting several higher-ordered structures including rod-shape, globular, and ring-shape (toroid) structures. This talk discusses the origin of these versatile higher-ordered structure formations when and how DNA is organized into these structures upon complexation with block catiomers, and also addresses a challenge to utilize the polyplex micelles as a potent gene vector for cancer therapy particularly to intractable pancreatic tumor.

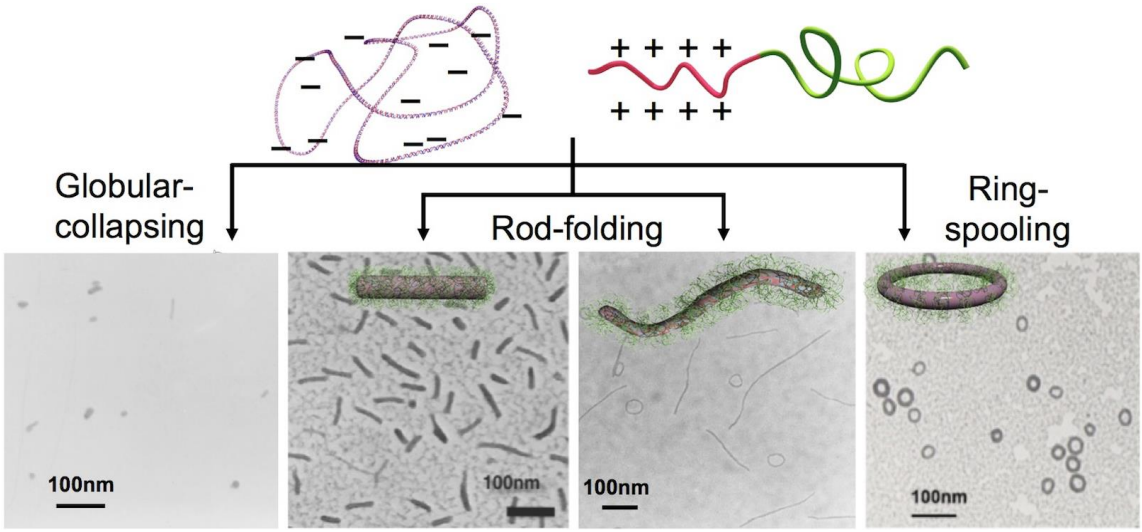

Fig. 1. Control of versatile higher-ordered structures of pDNA by block copolymers

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Reference
[1] H. Cabral, K. Miyata, K. Osada, K. Kataoka, Block copolymer micelles in nanomedicine applications. *Chemical Review* **118** 6844-6892 (2018)

Confocal Raman imaging for biological and life science research

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Chemical imaging, especially confocal Raman microscopy, has become an indispensable technique in biological and life science research. Not only the benefit of confocal imaging which can be used to probe the structures both superficially and internally in micron scale, the coupled Raman spectrometer can also help identifying chemical compositions of the structure of interest. With this technique, scientists can vividly gain information beyond that can be gained from conventional cell biology techniques. With the ability to vividly visualize all the different chemical components, identification of pathological effects such as cancers is not beyond the scope of research. Advanced research for new biocompatible materials for drug delivery systems and coatings for medical instruments have also ben benefiting greatly by this versatile technique. Correlative microscopy techniques such as confocal Raman-SEM and the other, coupled with advanced data-processing software such as 3D volumetric image construction and particle analysis, enable even more in-depth understanding of materials' structures, compositions and behaviors. Outside the scope of biological and life science, confocal Raman microscopy and its correlative techniques see a great number of applications in the fields of advanced material researches.

Accreditation supports to the supply chain

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Innovation industrials are the most worldwide topic issues. Why do the new industrials need to have an innovation. Competitiveness is more significance for enhancing the international trade of each economy. Moreover, the liability of industrial products should be accepted by the customers. Innovation industrial need to know how to building trust, accreditation system, the approaches how accreditation supports supply chain and ensuring the validity of results. The benefits of accredited CABs are as follows: The MRA supports international trade by promoting international confidence and acceptance of accredited testing and inspection reports and proficiency testing programs. Technical barriers to trade, such as the retesting of products each time they enter a new economy is reduced. In this way, the free-trade goal of "accredited once, accepted everywhere" becomes a closer reality. Organisations are already using the MRA in a positive way, For Government, The MRA provides governments with a credible and technically robust framework on which to further develop and enhance government to government bilateral and multilateral international trade agreements. The long-term aim is the fully accepted use and recognition, by both public and private industries, of accredited laboratories, inspection bodies and proficiency testing providers, including results from accredited facilities in other countries. In this way, the free-trade goal of "accredited once, accepted everywhere" will be realized.

Synchrotron application for material researches and Innovation

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Synchrotron Light Research Institute (SLRI, Public Organization) is a national laboratory which located at Nakhon Ratchasima, Thailand. SLRI provides synchrotron light for structural analysis, research and development. Currently, SLRI has 10 beamline and 12 end-stations in operation for scattering, diffraction, spectroscopy, imaging and micro fabrication. SLRI also has the IAR (Industrial application research) division for industrial service. In this talk, the synchrotron technique and application for material researches and Innovation (e.g. vulcanization of natural rubber, investigation structure of Li-ion battery and lab-on-a-chip technology) will be presented.

Highly ordered nanostructures of lipo-complexes of oligo-DNA driven by membrane undulations

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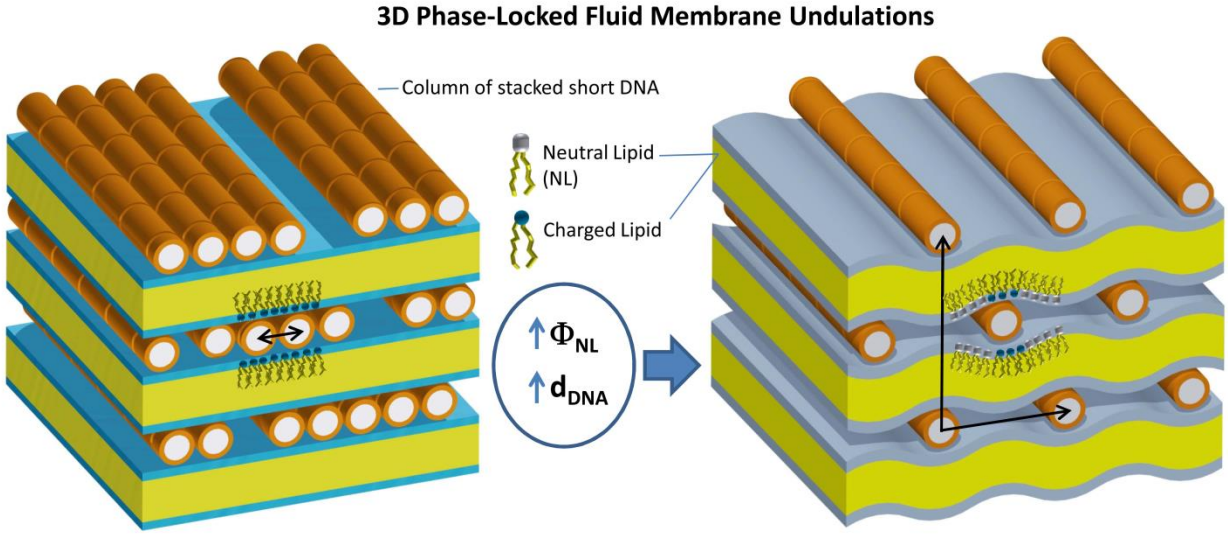
Lipo-complexes formed with cationic lipids and nucleic acids (e.g. DNA and RNA) are been actively investigated for wide ranging biomedical applications, including in gene therapy and drug delivery. The complexes form spontaneously via a self-assembly process driven largely by electrostatic forces between cationic lipids and anionic nucleic acids molecules (emtropic forces also play a key role). In this talk, results from recent studies in our group using small angle x-ray scattering (SAXS) on short DNA molecules complexed with cationic lipids are presented. We discovered that a highly organized lipid-nucleic acid phase emerges upon intercalation of blunt duplexes of short DNA (sDNA) within cationic multilayer fluid membranes. End-to-end interactions between sDNA leads to columnar stacks. At high membrane charge density, a 2D columnar phase is found similar to the phase in cationic liposome-DNA complexes with long lambda-phage DNA. Remarkably, with increasing d_{sDNA}, a transition is observed to a 3D columnar phase of stacked sDNA. The finding that this new phase is stable at large d_{sDNA} and enhanced with decreasing membrane rigidity is further supportive of a model where membrane undulation is the key driving force for sDNA ordering. The findings have broad implications in the design of membrane-mediated assembly of functional nanoparticles in 3D.



Oxide nanosheets for functional soft materials

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Inorganic layered crystals such as mica and graphite have been investigated as intriguing two-dimensional systems[1, 2]. Molecules can be adsorbed onto the surface or intercalated into the interlayer nanospace of the layered crystals. The atomically flat, uniformly charged, and chemically modifiable surface of the layered crystals with defined crystalline structure are ideal model systems to confine the adsorbed molecules, align them, and organize them in controlled manner, resulting in various functions such as polarized emission.[3] Further, intercalation of layered crystals with a large amount of solvent molecules leads to swelling[4] or exfoliation[5] of the crystal. After full exfoliation, inorganic nanosheets with the thickness of 1 nm are obtained. Because nanosheets are ultimately anisotropic functional nanoparticles with various function, they are applicable to fabricate advanced materials such as nanosheet/polymer composites[6], porous materials,[7] liquid crystalline colloids,[8, 9] and bio/inorganic composites with DNA[10] and motor-protein.[11] In this lecture, some selected topics of our researches on inorganic layered crystals and nanosheets will be presented.

References

[1] N. Miyamoto, S. Yamamoto, in *Supramolecular Nanoarchitectonics*, ed. by K. Ariga, M. Aono, Elsevior, **2017**, pp. 173.
[2] N. Miyamoto, Y. Ohsedo, T. Nakato, in *Inorganic Nanosheets and Nanosheet-Based Materials*, ed. by T. Nakato, J. Kawamata, S. Takagi, Springer Japan, Tokyo, **2017**, pp. 201.
[3] N. Miyamoto, K. Kuroda, M. Ogawa, *J. Am. Chem. Soc.* **2001**, *123*, 6949.
[4] F. Geng, R. Ma, A. Nakamura, K. Akatsuka, Y. Ebina, Y. Yamauchi, N. Miyamoto, Y. Tateyama, T. Sasaki, *Nature Commun.* **2013**, *4: 1632*.
[5] N. Miyamoto, H. Yamamoto, R. Kaito, K. Kuroda, *Chem. Commun.* **2002**, 2378.
[6] N. Miyamoto, M. Shintate, S. Ikeda, Y. Hoshida, Y. Yamauchi, R. Motokawa, M. Annaka, *Chem. Commun.* **2013**, *49*, 1082.
[7] B. P. Bastakoti, Y. Li, M. Imura, N. Miyamoto, T. Nakato, T. Sasaki, Y. Yamauchi, *Angew. Chem. Int. Ed.* **2015**, *54*, 4222.
[8] N. Miyamoto, T. Nakato, *Adv. Mater.* **2002**, *14*, 1267.
[9] D. Yamaguchi, N. Miyamoto, T. Fujita, T. Nakato, S. Koizumi, N. Ohta, N. Yagi, T. Hashimoto, *Phys. Rev. E.* **2012**, *85*, 011403.
[10] N. Yamguchi, S. Anraku, E. Paineau, C. R. Safinya, P. Davidson, L. J. Michot, N. Miyamoto, *Sci. Rep.* **2018**, *8*.
[11] R. Kato, A. Kakugo, K. Shikinaka, Y. Ohsedo, A. M. R. Kabir, N. Miyamoto, *ACS Omega* **2018**.

Glycoengineering based on biomolecular molecular science

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Biomolecules generally possess motional freedoms under physiologically solvated conditions. Oligosaccharides represent one of the most extreme classes of biomolecules that are characterized by conformational flexibility. Hence, oligosaccharide structures have been described as conformational ensembles. It has been supposed that lectin selects and captures specific conformational species of oligosaccharides among the ensemble, thereby promoting biological functions. Upon their interactions, the oligosaccharides may further undergo conformational deformation to fit into the binding pocket of lectin. Therefore, to gain quantitative insights into the energetics of carbohydrate recognition by lectins, detailed structural information is needed concerning their target oligosaccharides in both the precomplexed and lectin-complexed states. Moreover, such knowledge is crucial to design artificial oligosaccharides with improved functionality. We have developed a method to elucidate the dynamic conformations of oligosaccharides in solution employing molecular dynamics simulation with a paramagnetism-assisted NMR technique. We herein attempt to apply this method to design unnatural oligosaccharides with higher affinities for a specific target lectin using an oligosaccharide containing Lewis X (Fig.1) as a model. By inspecting the conformational ensemble of the oligosaccharide in the *prebound* state, we chemically remodeled its conformational space with an increased population of conformational species that can be accommodated in the carbohydrate-binding pocket of the target lectin without steric hindrance [1]. Our approach, complementing the lectin-bound-state optimizations, offers an alternative strategy to create high-affinity oligosaccharides by increasing populations of on-pathway metastable conformers. We furthermore created a *cyborg* supramolecule by hybridizing a self-assembled, spherical complex with oligosaccharides containing Lewis X, which exhibited homophilic hyper-assembly in aqueous solution in a Ca^{2+}-dependent manner through specific carbohydrate–carbohydrate interactions [2]. Moreover, we created Lewis X-carrying neoglycolipids that evoke selective apoptosis in neural stem cells [3]. We are currently undertaking to produce Lewis X-carrying glycoproteins by recombinant techniques.

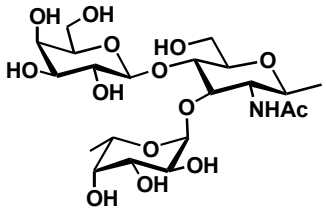

Fig.1 Lewis X

References
[1] T. Suzuki, *et al.*, Biochemistry (2020) in press.
[2] G. Yan, *et al.*, Chem. Asian J. 12, 968 (2017).
[3] H. Yagi, *et al.*, Neurochem. Res. 43, 212 (2018).

Organic Spin Filter Based on Motor Molecule

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Artificial molecular switches and machines that enable the directional movements of molecular components by external stimuli have undergone rapid advances over the past several decades. Particularly, overcrowded alkene-based artificial molecular motors are highly attractive from the viewpoint of chirality switching during rotational steps. However, the integration of these molecular switches into solid-state devices is still challenging. In this presentation, an example of a solid-state spin-filtering device that can switch the spin polarization direction by light irradiation or thermal treatment will be presented. This device utilizes the chirality inversion of molecular motors as a light-driven reconfigurable spin filter owing to the chiral-induced spin selectivity effect. Through this device, we found that the flexibility at the molecular scale is essential for the electrodes in solid-state devices using molecular machines. The present results are beneficial to the development of solid-state functionalities emerging from nano-sized motions of molecular switches. [1]

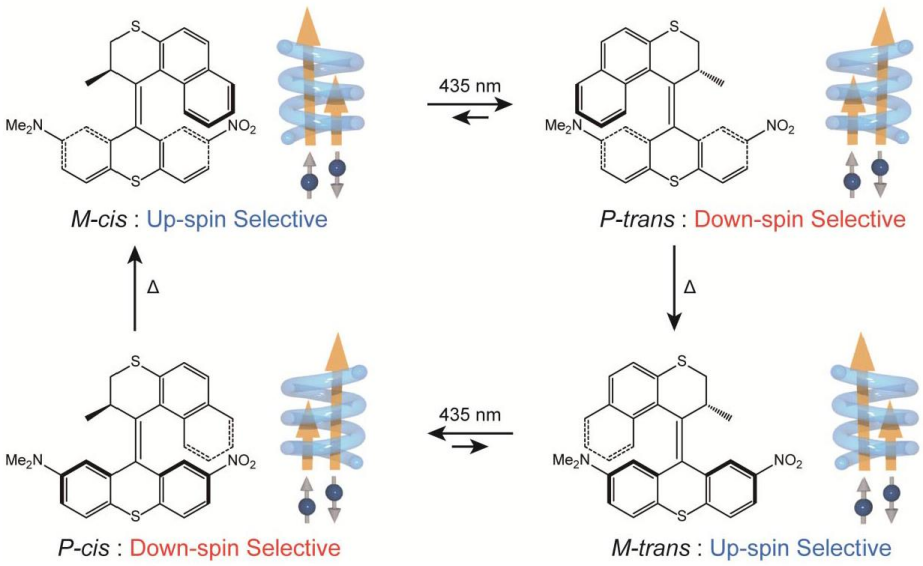

Fig. 1. Spin selectivity switching by a motor molecule.

References

[1] Suda, M., *et al*, *Nature Commun.* **10**, 2455 (2019).

Molecular insight into protein aggregation by computer simulation

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Many proteins aggregate at higher concentrations and form spherical substances called oligomers and acicular substances called amyloid fibrils (Fig. 1). These protein aggregates cause more than 30 kinds of diseases, for example, Alzheimer's disease is thought to be caused by the oligomers and amyloid fibrils formed by aggregation of amyloid-β (Aβ) peptides. To investigate the oligomerization process of Aβ, we developed Hamiltonian replica-permutation molecular dynamics (MD) method and applied this method to Aβ in explicit water solvent [1-4]. We will show the oligomerization process of Aβ. We also performed MD simulations of Aβ amyloid fibrils in explicit water. We discovered that molecular structure is different between two ends: The two β-sheets β1 and β2 are close to each other. On the other hand, at the odd end the Aβ peptide fluctuates more and takes an open form, too [5]. Our theoretical prediction was proved by experiment after our MD simulations. Another topic of my talk is conformational change of Aβ peptide by binding to monosialotetrahexosylganglioside (GM1)-glycan cluster. Recent studies showed that GM1 clusters induce the pathological aggregation of Aβ peptide responsible for the onset and development of the Alzheimer's disease. However, the effect of GM1-glycan cluster on Aβ conformations has yet to be clarified. We performed MD simulations of Aβ on a recently developed artificial GM1-glycan cluster [6].

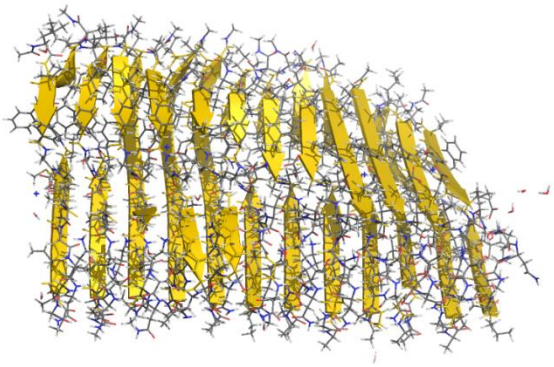

Fig. 1 Snapshot of Aβ amyloid fibril.

References

[1] S. G. Itoh and H. Okumura, J. Comput. Chem. (2013) 34 2493.
[2] S. G. Itoh and H. Okumura, J. Phys. Chem. B (2014) 118 11428.
[3] S. G. Itoh and H. Okumura, J. Chem. Theory Comput. (2013) 9 570.
[4] S. G. Itoh and H. Okumura, J. Phys. Chem. B (2016) 120 6555.
[5] H. Okumura and S. G. Itoh, Sci. Rep. 6 (2016) 38422 (9 pages).
[6] Y. Tachi, Y. Okamoto, and H. Okumura, Sci. Rep. 9 (2019) 6853 (11 pages).

Bandgap science for organic solar cells

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Hall effect in bulk-doped organic single crystals and the reduction of open-circuit voltage loss in organic solar cells will be presented. Hall effect in bulk-doped organic single crystals. We have been reported that the effects of impurity doping at ppm level in photovoltaic organic semiconductors [1]. The number of carriers created by doping and their mobility can be freely evaluated by "Hall effect measurement" using a magnetic field. However, in the field of organic electronics, no one has ever attempted to dope impurities into an organic single crystal itself nor measure its Hall effect. Recently, we have combined the rubrene organic single crystal growth technique with our original ultra-slow deposition technique of 10^{-9} nm/s, which includes a rotating shutter having aperture, and we have succeeded in producing the ppm-level doped organic single crystal and have detected its Hall effect signal (Fig. 1) [1,2]. The doped organic single crystals can be used for organic single crystal solar cells [3]. Reduction of open-circuit voltage loss in organic solar cells. Reducing the energy loss in output voltage is critically important for further enhancing the efficiency of organic solar cells. We report that organic solar cells with high mobility and highly crystalline donor and acceptor materials can reduce an open-circuit voltage (V_{oc}) loss [4]. V_{oc} was reached to theoretical (Shockley–Queisser) limit due to the complete suppression of non-radiative recombination (red dots) (Fig. 2) by increasing the interfacial crystallinity.

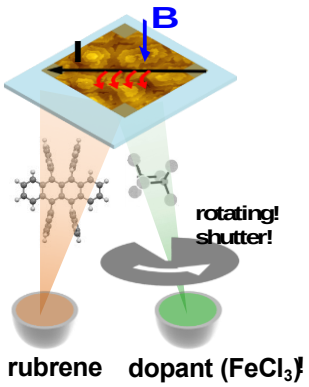

Fig. 1. Ultra-slow co-deposition.

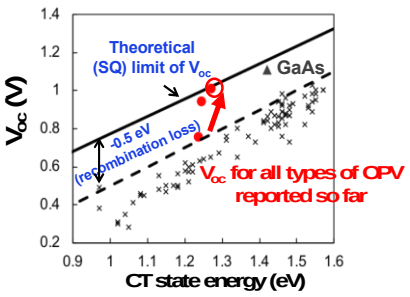

Fig. 2. V_{oc} reaching to theoretical (Shockley–Queisser) limit (red dots).

References

[1] M. Hiramoto, S. Izawa et al., Adv. Mater., 30, 1801236 (2018) [Invited Progress Report].
[2] C. Ohashi, M. Hiramoto et al., Adv. Mater., 29, 1605619 (2017).
[3] M. Kikuchi, S.Makmuang, M. Hiramoto et al., *Org. Electron.*, 64, 92 (2019).
[4] S. Izawa, M. Hiramoto et al., Appl. Phys. Lett., 115, 153301 (2019).

Energy and spatial distribution of frontier orbital state for organic thin films

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Functional organic molecule (FOM) has recently attracted considerable attention both on fundamental research and device applications because of peculiar properties not found in inorganics and small molecules. However the mechanisms and its origin of various device characteristics are still under controversial. Scientific mysteries would be raised because people have believed that electronic structure of FOM would be conserved or at least approximated as in an isolated molecule for solid state due to weak van der Waals interaction. To reveal characteristics of FOM in a solid a key investigation would be on precise experiments on the electronic structure at various bound interfaces, including organic-organic and organic-inorganic (metal/semiconductor) contacts. High-resolution angle-resolved photoelectron spectroscopy of organic monolayer and bilayer films of perfluoropentacene (PFP) prepared on Ag (111) and graphite substrates are performed to reveal the impact of weak electronic interaction and strong electron-phonon coupling on the molecular orbital states [1-4]. By comparing two weakly interacting interfaces, we confirm the localization of wave-function spread of each state at the physisorbed interface and shed light on the character of a shape of a molecule, namely delocalization of wave function of pi orbital. Recent preliminary results taken by the state-of-the-art momentum microscopy which allows to give a global view of an electron cloud with very high-throughput experiments, which is an important factor in measuring the electronic states of FOM due to irradiation damages, will be shown to discuss.

References

[1] S. Kera and N. Ueno, J. Electron. Spectrosc. Relat. Phenom. 204, 2 (2015).
[2] S. Duhm, S. Hosoumi, I. Salzmann, A. Gerlach, M. Oehzelt, B. Wedl, T-L. Lee, F. Schreiber, N. Koch, N. Ueno, and S. Kera, Phys. Rev. B 81, 045418 (2010).
[3] S. Kera, S. Hosoumi, K. Sato, H. Fukagawa, S. Nagamatsu, Y. Sakamoto, T. Suzuki, H. Huang, W. Chen, A.T.S. Wee, V. Coropceanu, and N. Ueno, J. Phys. Chem. C 117, 22428 (2013).
[4] Y. Nakayama, R. Tsuruta, N. Moriya, M. Hikasa, M. Meissner, T. Yamaguchi, Y. Mizuno, T. Suzuki, T. Koganezawa, T. Hosokai, T. Ueba, and S. Kera, J. Phys. Chem. Lett. 10, 1312 (2019).

ORAL PRESENTATION

Effect of composition ratios and mixing steps on properties of BR/NR/NBR blends and blends foam

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This research is aimed to prepare foam from BR/NR/NBR blends which should integrate key property of these three rubbers. BR possesses high abrasion resistance but low tensile strength while NR possesses high tensile strength [1]. The addition of NBR was advantage for non-polar solvent resistance [2]. The effect of the mixing steps of rubber with vulcanizing additives on vulcanization of rubber and on mechanical properties and foaming of BR/NR/NBR were reported. The ratios of BR/NR/NBR were various as 80/0/20, 60/20/20, 40/40/20, 20/60/20 and 0/80/20. The vulcanizing additives used for rubber compounding were 5 phr ZnO, 2 phr stearic acid, 1.5 phr MBTS and 2 phr sulfur. The first part of the work was to study the effect of mixing step on rubber blends. Compounding System I was carried out by masticated BR, NR and NBR on a two-roll mill after that vulcanizing agent was added consecutively obtaining BR/NR/NBR rubber compounds with various rubber compositions. Rubber compounds were then characterized and vulcanized in order to investigate vulcanizate properties. In System II, three rubbers were mixed separately with required vulcanizing additives on the two-roll mill, obtaining BR, NR and NBR compound containing the same content of vulcanizing agent. Then the compounds were blended to obtain compound blended for the same blend ratios in System I. The blended rubber compounds were then characterized and vulcanized for their properties. In term of rubber blend foaming these two mixing systems were also used to compound the rubbers by addition foaming agent into the compound during mastication or blending of rubber on the two-roll mill. The results showed that mixing step affected the properties of rubber compound and vulcanizate in rubber blend. As various rubbers were mixed in different step resulting in different viscosity and hence affect foaming of rubber and subsequently properties of rubber foam, as shown in Figure 1.

System 1 :

System 2 :

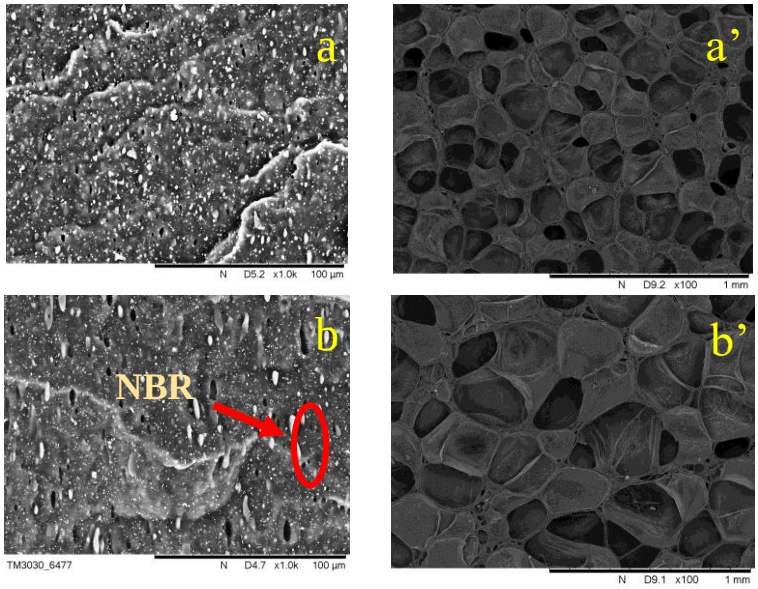

Fig. 1 SEM micrograph of BR/NR/NBR blend with the same rubber ratios System 1 (a) BR/NR/NBR foam System 1 (a') BR/NR/NBR blend System 2 (b) and BR/NR/NBR foam System 2 (b')

References

[1] M. N. Ismail, S. H. El-Sabbagh, and A.A. Yehia. Fatigue and mechanical properties of NR/SBR and NR/NBR blend vulcanizates. Elastomer and plastics. 31, 255-270. (1999).

[2] Matador Rubber. RUBBER CHEMISTRY. Education and Culture Lifelong Learning Program Leonardo Da Vinci. (2007).

High pressure crystallization of nucleated polypropylene and polypropylene nanocomposites in the gamma-form

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The orthorhombic gamma form of isotactic polypropylene (PP) is unique because of a nonparallel chain arrangement. Gamma-PP can exhibit mechanical properties, for instance yield strength, superior to that of alpha-PP [1]. It is long known that crystallization of PP in the gamma-form is facilitated by high pressure, although it requires also high temperature. Polymers, including PP, are subjected to elevated pressure during injection molding. In the study, the role of nucleating agents in crystallization of PP under high hydrostatic pressure, up to 300 MPa, was investigated. It was found that the agents, which are used to nucleate crystallization of the alpha-modification of PP under atmospheric pressure, efficiently nucleated crystallization in the gamma-form under elevated pressure, increased nonisothermal crystallization peak temperature and strongly decreased grain sizes [2,3]. Moreover, during nonisothermal crystallization under 50-100 MPa the nucleants significantly increased the gamma-phase content in the crystalline phase [3]. The nucleating activity of sorbitol derivative under high pressure depended on its concentration in PP. SEM analysis of microstructure of permanganate etched specimens of nucleated PP, crystallized under high pressure, led to the conclusion, that the alpha-lamellae were nucleated first, and served as seeds for the gamma-form [4]. Moreover, high pressure crystallization of PP nanocomposites with 1-5 wt.% of organo-modified montmorillonite (o-MMT), multi-wall carbon nanotubes (MWCNT) and polytetrafluoroethylene (PTFE) nanofibers was studied. It was found that MWCNT and PTFE nucleated crystallization of PP in the gamma-form under high pressure, whereas o-MMT did not.

References

[1] C. von Baeckmann, H. Wilhelm, F. Spieckermann, S. Strobel, G. Polt, P. Sowinski, E. Piorkowska, A. Bismarck, M. Zehetbauer, Thermochim. Acta 677, 131 (2019).
[2] P. Sowinski, E. Piorkowska, S.A.E. Boyer, J-M. Haudin, K. Zapala Colloid Polym. Sci. 293, 665 (2015).
[3] P. Sowinski, E. Piorkowska, S.A.E. Boyer, J-M. Haudin, Eur. Polym. J. 85, 564 (2016).
[4] P. Sowinski, E. Piorkowska, S.A.E. Boyer, J-M. Haudin, Polymer, 151, 179 (2018).

Assessment of human health impact based on life cycle assessment: A case study of Thai retread tire

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The sustainable production of tire supply chain has been recently highlighted to reduce the environmental and human health impacts. The main environment problem of tire supply chain is waste treatment. When the tires reach the end of their working life, they are recycled (obtaining raw materials and other components for certain manufacturing processes) or burned (obtaining energy). During the exploitation, a tire with worn tread can be processed in a certain way to allow its reuse. The retreated tire should be accepted for further treatment. Hence, this study conducted the human health impacts of retread tire using life cycle assessment. The recipe2016 technique and Sigmaoro 9.0 software were used as the method of human health assessment. The result showed that the total value of human health impact assessment for retreated tire production were 4.3007E-06 Daly. The hotspot of human health impact for retreated tire production was tire material and electricity consumption. Form this finding will help designers or managers recommend the installation scenario of retreated tire production by considering human health impacts.

Enhancement of the tire rolling resistance testing machine

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Rubber tree is an outstanding product in commercial area of Thailand. Tire is one of the prominent and downstream products as components in the automotive industry with a high production capacity. While tires are used widely, a regulation for the rolling resistance of tires has been set up by the European Commission. Therefore, the operators must test their products. By the high costs for the testing before certification, the researchers realize the limitation of the test equipment suffering with the small and medium enterprises that do not have access to check their tires. This is the weakness of the tire industry in Thailand. Therefore, the low-cost of tire rolling resistance testing machine has been built in accordance with the UNECE Regulation No. 117 which is accepted worldwide. As a result, the in-house tire rolling resistance testing machine is compared with the imported one in terms of cost production. The budget can be reduced up to 50 % since the test equipment can be produced with currently technology in the country. Moreover, this is the self-reliance of technological machinery industry. For the working result, it was found that the vibration level of tire rolling resistance testing machine consented to the standard ISO 10816. Besides, the experimental results of tire rolling resistance coefficient is compliance with the requirements UNECE Regulation No. 117 Annex 6 and also verified by the international authority (TUV Rheinland Thailand Ltd). It can reduce the limitation in terms of the testing and also support the economic expansion of the production of quality tires in the country to be accepted in international level.

A wide energy range neutron shielding material based on natural rubber and boron

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Neutron have been used in many applications. Neutrons have no electric charge and have a high penetrating power. Therefore, the use of neutron shielding material is one of the effective methods to prevent neutron radiation hazards. In this work, neutron shielding materials were designed using the Monte Carlo N-Particle (MCNP) transport code in order to select proper materials for a wide energy range neutron shielding. Thicknesses of 1 cm and 4 cm were chosen for shielding neutron in the wide energy spectrum (10E-8 - 100 MeV). MCNP simulation results indicated that the best shielding material was 2 layers of 2 cm natural rubber (NR) and 2 cm NR with 20 part per hundred rubber (phr) boron powder. This shielding material can reduce the neutron dose by 17.91 ± 0.09 % with the total macroscopic cross section of 0.042 cm^{-1}. The optimal neutron shielding materials were fabricated. The mechanical properties and aging properties of shielding materials was found to meet the requirement of Thai Industrial Standard (TIS 2377-2551 Rubber flooring). Therefore, the designed shielding material can be utilized to shield against wide energy range neutrons.

Using of polymer blends base on natural rubber latex/acrylic emulsion as binder for building paint

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The blending of natural rubber latex/acrylic emulsion used as a binder for building paint was investigated in this study, and the influence of natural rubber contents on physical and mechanical properties was studied. The pre-vulcanized natural rubber latex was firstly prepared and blend with the acrylic emulsion at various blend ratios later; 30/70, 40/60, 50/50, 60/40, and 70/30. The optimal stress-strain curve behavior has occurred when blending natural rubber/acrylic emulsion at ratio 30/70, high strength and elongation at break. Adding natural rubber content more than 30% results in dropping the strength and elongation at bleak. It can be expected that the elasticity phase of the natural rubber and stiffness phase of acrylic is mixed properly in this ratio. The gel content after swollen these polymers blends in a un-polar solvent such as toluene for estimation of the blending behavior also characterized. Blending at 30/70 shows completely dissolved, but the gel content increase as a function of natural rubber content in the ratio of the other. It indicated that blending these polymers at this ratio is optimal and appropriate for use as a binder for building paint.

Study on processability and mechanical properties of parawood-power filled PLA for 3D printing material

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Recently, there has been an increasing interest in the development of 3-Dimensional (3D) printing technologies. Among those, material development play an important role in helping the growth of 3D printing technique, which led to more supporting of wide range of applications and user requirements. In that regards, advanced materials are continually developed, i.e. filament filled reinforcing fiber and plastic containing metal granulate or wood powder. Special material supporting 3D printer normally showed an expensive cost. On the other hand, it is well known that the processes involving natural rubber from Para rubber trees produced a large amount of wood a year, which resulted in releasing of an abundant waste from wood processing. Therefore, this work focused on the utilization of parawood powder derived from the furniture industry. The processability of polylactic acid (PLA) filament containing wood powder was investigated. Twin and single-screw extrusion machines were used to produce the composite filaments. Coupling agent and treated method were also studied. The results of this work showed that the maleic anhydride (MAH) and sodium hydroxide (NaOH) did not have significantly effects in improving the compatibility and processability. In addition, wood contents was found to influence the quality of filament and mechanical properties. Moreover, it was also found that parawood powder can be filled into PLA with approximately 10 wt%.

Effect of acrylonitrile butadiene rubber on the properties of silica-reinforced natural rubber

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The effect of acrylonitrile butadiene rubber (NBR) as a compatibilizer in silica-reinforced natural rubber (NR) is studied. NBR, Emulcril 3380 with 32-34%, was various at 5, 10, 15, 20 and 25 part per hundred parts of rubber (phr) to be used as a compatibilizer for silica-filled NR. The use of NBR as a compatiblizer can improve cure time (T90), cure rate index (CRI), and Mooney viscosity of silica-filled NR compounds, but the re-agglomeration of filler still observes. The use of NBR shows significantly effect on bound rubber contents. However, tensile strength, reinforcement index and tear strength increase with increasing amount of NBR contents due to a presence of some rubber-filler interaction through acrylonitrile groups of NBR and silanol groups on the silica surface. It leads to observe more surface roughness on tensile fractured surfaces.

On the mechanical properties of para rubber-oil palm ash derived geosynthetic clay liner

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The main objective of this project was to develop a Geosynthetic Clay Liner using local materials. The clay core was produced from kaolinite mined in Ranong mixed with oil palm ash (OPA) that can be obtained with no cost. The clay to OPA ratios were varied from 100:0, 80:20, 70:30, 60:40, and 50:50. In addition, compound latex was applied to the mixtures as binder. The wrapper was made from unbleached cloth that was thinly one-side coated with the compound latex. Both basic and engineering properties then were determined in order to evaluate whether the GCL developed had quality that could be employed in the field. It was found that the average particle sizes for the clay and OPA were 0.0129 and 0.0172 mm, respectively. The permeability was highest when there was no OPA added. When the OPA was increased, however, the permeability gradually decreased; and, the lowest value was achieved when the OPA was 30%, indicating the most effective mix in terms of preventing the flow of leachate. The punching resistance and tensile strength are ones of the most important parameters for the wrapper. It was found that the wrapper developed had more than enough punching resistance. However, its tensile strength was lower than the value set by the standard. Please be noted that the strength indicated was from the geotextiles normally used in other civil engineering work that needs quite strong material. In this case, however, the GCL is buried underground and there is little tensile strength generated. Thus, from engineering point of view, the wrapper developed is good enough to be employed as GCL. In addition, the cost for developing the GCL was found to be approximately 113 Thai Baht per square metre. Comparing to the commercial GCLs that cost around 300 – 500 Thai Baht, it may be concluded that it is advisable to produce our own GCL instead of import.

Acoustic Board from Sea Oak

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The objective of this research is to develop an acoustic board from sea oak. The selected sea oak was a mature fruit. That had been passed though shredder. The shredded sea oak was analyzing by shaking through 6 sieves: No. ¼ (6.3 mm.), No. 10 (2 mm.), No. 16 (1.18 mm.), No. 20 (850 µm.), No. 30 (. 600 µm.) and No. 40 (425 µm.). Samples were using a powder glue as a binder. The ratio of the raw material by weight is 4: 2: 3 (Sea oak: Water: Powder glue); Then molded using the heat compression at 80ºc by 80 psi for 15 minutes. There are 6 testing sets with 2.5 centimeter as the thickness: set S1 (The shredded sea oak from sieve No. ¼ (6.3 mm.)), set S2 (The shredded sea oak from sieve No. 10 (2 mm.), set S3 (The shredded sea oak from sieve No. 16 (1.18 mm.)), set S4 (The shredded sea oak from sieve No. 20 (850 µm.)), set S5 (The shredded sea oak from sieve No. 30 (. 600 µm.) and set S6 (The shredded sea oak from sieve No. 40 (425 µm.). Results showed that the physical characteristics of set S6 give the highest density with density of about 979.40 kg/m3.Set 1.A shows sound absorption levels over 0.40 when the first frequencies range from 750 -1172 Hz, the second frequencies range from 1351 -6400 Hz and the maximum 98% of sound absorption level when the frequencies range at 2100 Hz .The Noise reduction coefficient (NRC) is 0.43 which passes the lower limit of sound absorbing materials (0.40).Set S3 shows the lowest thermal conductivity (k) at 0.017 W/ (mK) and its insulating property is better than Polyurethane Foam that the lowest thermal conductivity (k) at 0.021 W/ (mK) which are available in the market. And all the testing sets were passing The Physical test from the standard of TIS 876-2547. Therefore, sea oak acoustic boards have potential for further development as acoustic boards. It could be an alternative material that is Eco-friendly. This will also add value to waste from the nature.

Injection-molded polyethylene/natural rubber blends

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Thailand is up to now the largest producer and exporter of natural rubber (NR) in the world with 40% of global production. However, only around 18% of midstream NR products were consumed in Thailand as raw materials in the manufacture of downstream vulcanized NR products including tires, elastic, latex gloves, rubber bedding and elastic bands, etc., while the rest (82%) is exported for additional processing to produce end products in factories abroad. This makes Thailand loss a chance to enhance its income. Therefore, the development of downstream high value-added NR is very important at this stage. The present work demonstrates the fabrication of polyethylene (PE)/natural rubber blends for injection-molded articles (Fig. 1). The effect of NR on properties of PE was investigated. Melt flow ability of the blend decreased with increasing NR content. Although PE/NR blend (60/40 w/w) showed lower tensile strength and Young's modulus than PE, its elongation at break and impact strength were higher. However, the increased NR content up to 50 wt% did not improve extensibility and impact properties of the blend. In addition, hardness and heat distortion temperature also decreased with increasing NR fraction. The obtained materials are thermoplastics, which contain fewer chemicals as compared with the conventional vulcanized NR products and possess recyclability and less time-consuming converting process similar to the cases of conventional thermoplastics.

Fig. 1. Injection-molded prototypes of polyethylene/natural rubber blends

Effect of Fe Doping on Photocatalytic Activity of TiO_2 Hollow Fibers under LED Light Irradiation

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Fe-doped TiO_2 hollow fibers (Fe-TFs) were fabricated using the biotemplate method with kapok as the template. The amount of iron (III) nitrate was varied from 0 to 1 wt%. The kapok template was removed by calcination at 450 °C for 1 h to obtain a hollow structure and crystallized TiO_2 [1]. The X-ray diffraction (XRD) results showed that undoped and Fe-TFs identified only anatase phase. Scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) were used to observe the Fe-TF morphology, which had a hollow structure with uniform dispersion of the Fe dopant. From the diffuse reflectance spectroscopy (DRS) measurement, the bandgap energy of Fe-TFs decreased from 3.21 to 2.87 eV as increasing the amount of Fe dopants. Investigation of degradation of methylene blue under visible light from light-emitting-diode (LED) irradiation showed that the optimum condition was 1 wt% of Fe-TFs due to its lowest bandgap and Redshift-phenomenon. In addition, Fe^{3+} ion acted as the electron-hole trapping to prevent the recombination of both species [2].

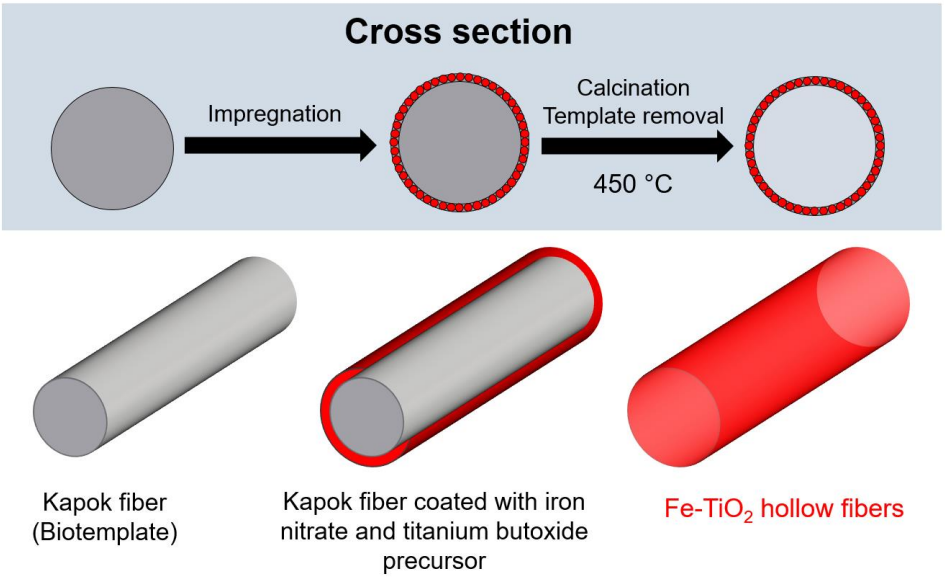

Fig. 1. Schematic diagram illustrating the synthesis of Fe-TFs.

References

[1] S. Wongcharoen and G. Panomsuwan, Mater. Lett. 228, 482–485 (2018).
[2] M. Marami, *et al*., Min. Met. Mat. Soc. 47, 3741–3748 (2018).

Performances of cellulose nanofiber reinforced composites prepared by Pickering emulsification

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A simple and environmentally friendly Pickering emulsification process was introduced to prepare transparent and tough CNF reinforced composites of the immiscible acrylic polymer without any cellulose modifications or compatibilizers. The improvement of mechanical properties associated with enormous increase in toughness was observed with the introduction of CNFs. With the addition of 4 wt%, tensile strength, modulus and strain of the composites were 21.3 MPa, 0.67 GPa and 7.0 %, respectively, in comparison to those of the neat acrylic resin polymer (strength, modulus and strain of 2.2 MPa, 0.03 GPa and 7.0 %). With increasing CNF contents, the signification increase of the mechanical properties with no sacrifice of flexibility and optical transparency was observed. Furthermore, when 24 wt% of CNFs was added into the acrylic resin, the thermal dimensional stability of the composites was comparable to that of the glass substrate (7.3 ppm K-1) while the neat acrylic film had the thermal expansion of 192.3 ppm K−1. These flexible transparent composites might draw attentions for a new era as flexible substitute materials to glass or polymer substrates in optoelectronic or solar cell applications.

Removal of fluoride ions from groundwater using surface-modified ultrafiltration membrane

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Despite effectiveness of reverse osmosis membrane in removing fluoride from groundwater, its limitations involve low water permeability and high energy consumption [1, 2]. In this research the surface of PES ultrafiltration (UF) membrane that cannot reject fluoride was coated with zeolitic imidazolate framework no.8 (ZIF8) to enhance fluoride removal through size exclusion mechanism at practical operating fluxes. The objective was to evaluate performances of the virgin, ZIF8-coated and NF270 membranes in terms of water permeability and fluoride rejection. ZIF8 was synthesized in the lab and coated on the membrane surface with the layer-by-layer method at room temperature and atmospheric pressure [3]. Membrane filtration was performed using a pressurized cell with dead-end configuration. The water permeability was calculated from pure-water flux at 3 different operating pressures, i.e. 1.0–1.8 bar, and the membranes were tested for the fluoride removal with the initial fluoride concentration of 5 ppm. In Fig.1, the water permeability of the ZIF8-coated membrane was found about 20% lower than the virgin UF membrane, suggesting existence of the ZIF8 layer. Rejection of fluoride will be presented as a function of filtered volume for each membrane.

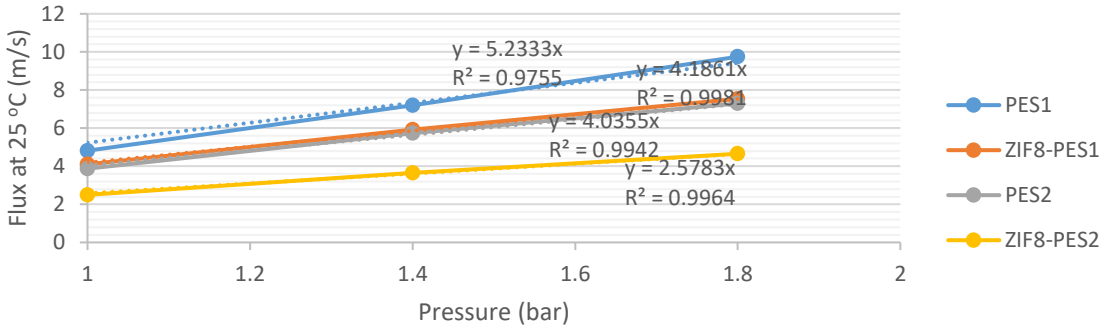

Fig. 1. Operational pressure and flux of virgin and ZIF8-coated membranes.

References

[1] Matsui, J. 2007. Fluoride removal from groundwaters using nanofiltration process. Ph.D. diss., The University of Tokyo.
[2] Tahaikt, M., R.E. Hannani, A.A. Haddou, I. Achary, Z. Amor, M. Taky, and A. Elmidaoui. 2007. Fluoride removal from groundwater by nanofiltration. Desalination 21:46-53.
[3] Kida, K., K. Fujita, T. Shimada, S. Tanaka, and Y. Miyake. 2013. Layer-by-layer aqueous rapid synthesis of ZIF8 films on a reactive surface. Dalton Trans 42:11128-11135.

Enhanced interfacial dielectric polarization in PVDF-HFP copolymer with treating PPy by using silane coupling agent

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Dielectric materials are polar materials for energy storage applications such as capacitors, transformer, and other electrical devices. The great dielectric properties generally depend on easily switchable polarization and higher-order structure in material. Filler composite in the flexible dielectric polymer is then considered to rearrange polymer chain. However, the filler becomes agglomeration easily at high loading content in polymer, resulting in high energy loss and low electrical breakdown. This work presents the treated Polypyrrole (PPy) filler by 3-Aminopropyltriethoxysilane for avoiding agglomeration in PVDF-HFP thin film. These 30 μm PVDF-HFP film thickness is fabricated by tape casting method with *N,N*-dimethylformamide (DMF) solvent. The distributions of PPy filler on PVDF-HFP are observed by SEM image. Dielectric constant, dielectric loss, and conductivity are analysed. As a result, the silane in 1%wt on PPy filler is decreasable dielectric loss and conductivity with increasing dielectric constant. It seems that the insulating silane has functioned to cover conductive PPy filler, and connected with polymer chain for easily switchable polarization when applied electric field. Surprisingly in the suitable 1%wt silane, dielectric constant has increased by 2.5 times compared with non-silane. However, the larger than 1 %wt silane seemly reduces dielectric properties. Treated PPy with the suitable silane content in PVDF-HFP performs good dielectric properties for advanced energy storage in this work.

The Modification of Steel Belt Layer of Airless Tire for Finite Element Analysis

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The airless tire can be considered as composite structure since it composed of several components with different materials for desired performance. The 3 main components of airless tire are rubber tread, shear band and polymer spokes. The shear band composed of 3 complex steel belt layers and should be considered as a sub composite structure. The finite element method can be used in designing and development of airless tire. However the diversity of materials in each component including the complex sub structure resulted in complicate modeling process and considerably long analysis time. Thus, the large computational resources are required to analyze those components. In this research, the simplification of modeling and analysis of airless tire was attempted by modification of steel belt layers. The Mooney-Rivlin hyperelastic model was used to describe the material properties of tread and spoke. The constitutive model constants were obtained by tensile and compressive test according to ASTM D412 and D575 standards, respectively. The simplified belt, which was developed by homogenization approach, was integrated into shear band component. The airless tire model with modified steel belt layers can be used to reduce the model complexity and analysis time while yield accurate results.

Mathematical model for decision making in production of upstream Para rubber product in the supply chain Case Study: Pluak daeng district, Rayong

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Para rubber farmers have to use their experience to decide their volume of production in order to make the highest profit. Farmers need to concern about many constraints to find the optimal-solution. This research presents the mathematical models in order to solve the product mix decision problem of the upstream Para rubber products based on Bottleneck method. Necessary constraints such as workstation time limit, machine capacity, raw material requirement, raw material limit and maximum volume were added. Two mathematical models were created to solve product mix decision problem for both a production unit and all production units under the total demand. The objective function is to maximize the profit. Lingo 11 was used to solve the problem. These models were applied to solve the product mix decision problem in two sub-districts, Rayong province. The mathematical model of product mix decision for a production unit provided the production volume and found the maximum profit for each farmer. The mathematical model of product mix decision for all production units under the total demand allocated the production volume to each farmer based on their resources. The constraints of models could utilize the farmer resources properly.

The Use of Physical Simulation to Evaluate Thermal Properties of Food Containers in Cold Chain Logistics

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Cold chain logistics has gained significant attention among all stakeholders in the Food and Pharmaceutical delivery industries due to the stricter Food Safety enforcement and tighter quality assurance [1-3]. Most cold chain logistics providers seek to determine the right packaging that ensures temperature control delivery in order to gain and/or retain their competitive advantage in the market place. Nowadays, materials such as Polystyrene Foam (PS foam), Polyethylene-Nylon (PE-Nylon), and Vacuum Insulation Panels (VIP) are widely used in the construction of delivery containers. The objective of this study is to use a physical simulation approach to determine which materials are most suitable for delivery containers. First, three delivery boxes with different materials (PS, PE-Nylon and VIP) were used as test subjects in this study. Second, the cold chain delivery process was simulated for each box and the temperature at each critical point had been measured throughout the delivery process. Third, data analysis was performed by comparing the temperature pattern among all three subjects. The thermal conductivity data for each box was calculated by mathematic equations to help interpret the results. The result showed that the box made from VIP material showed the best thermal conductivity. The application of this thermal conductivity estimation procedure might help guide food delivery related practitioners to determine the best materials for their delivery container equipment and the findings might help effectively and efficiently improve their delivery services.

References

[1] N. Ndraha, *et al.*, Food Control. 89, 12-21 (2018).
[2] E. Dieckmann, *et al.*, Food Packag. Shelf Life. 21, 100360 (2019).
[3] N. Ndraha, *et al.*, J. Food Eng. 242, 21-30 (2019).

Monte Carlo simulations of nanorod filler in stretched polymer nanocomposites

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The conductive polymer nanocomposites material (PNC) is one of alternative polymeric materials to replace the high-cost intrinsically conductive polymers (ICPs). PNC is composite of electrical insulating polymer matrix and electrical conductive nanorod filler. It has less complex synthesis and similar quantitative conductive properties to the existing ICPs. PNC is a candidate for many applications such as light-emitting diodes, flexible electrodes, batteries and strain sensor [1]. In this study, the in-house Monte Carlo simulation has used to estimate the nanorod density at percolation threshold [2]. We focused on the effects of lattice size and stretching lattice on percolation threshold. The length of lattice dimension lattice was varied with constant volume for each simulation system (incompressible material). The fitting parameters of percolation probability curve showed that the percolation threshold is not depended on lattice sizes. However, the slope of percolation probability curves increased as the increase of lattice sizes. In addition, the percolation thresholds decreased when increasing of the stretched lattice. Our finding will be the useful guidelines for designing conductive polymer nanocomposite as the switching sensor.

References

[1] S. Paszkiewicz, A. Szymczyk, *Nanomaterials and Polymer Nanocomposites*, Elsevier (2019).
[2] Belashi Azita, *Percolation modeling in polymer nanocomposites*, Theses and Dissertations, Paper 525 (2011).

Solvation of cellobiose in salt/DMAc and salt/water/DMAc

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Cellulose has strong inter- and intra-molecular hydrogen bond between hydroxyl groups, this affecting difficultly to dissolve in water and common organic solvents. However, it has found that cellulose can dissolve in some solvents, such as ionic liquids, and LiCl in aprotic solvent, such as dimethylacetamide (DMAc). In this work, we investigated the solvation structure of cellobiose, as a typical of cellulose, in 4 solvents, LiCl/DMAc, NaCl/DMAc, Ca_2Cl/DMAc and LiCl/water/DMAc by three-dimensional reference interaction site model (3D-RISM). To get the solvent-solvent correlations, we applied the dielectric reference interaction site model (DRISM), and we found that LiCl/DMAc has the strongest correlation of cation-cation and cation-O_{DMAc} correlation. The present of water in the DMAc/water mixture causes the losing of the correlation between cation. The three-dimensional distribution functions of solvents around the cellobiose were calculated by solving 3D-RISM equation with KH closure. Our results of demonstrate that Li^+ and Cl^- have strong interaction with the hydroxyl oxygen and hydrogen respectively, which is consistent with the previous hypotheses. However, the results indicate the Cl^- or O_{DMAc} can form strong H-bond to hydroxyl hydrogen and have strong interaction to Li^+ (Fig 1).

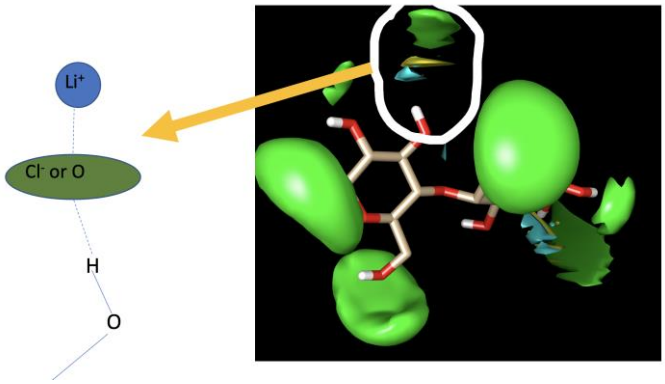

Fig. 1. 3D-DF of cation and anion around the cellobiose, g_{Li}>5 (green), g_{Cl}>60 (yellow) and g_O>20.

References

[1] C. Zhang, R. Liu, J. Xiang, H. Kang Z. Liu, and Y. Huang, J. Phys. Chem. B 118, 9507 (2014).
[2] T. R. Dawsey, C. L. McCormick, J. Macromol. Sci. -Rev. Macromol. Chem. Phys. C30, 405 (1990).

Transmission of charge ion in Single-walled Carbon Nanotube

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In this paper, we investigate the effects of the chiral structure of single-wall carbon nanotube (SWCNT) on the probability that an electron is transmitted (or reflected) through SWCNT. We use the electron density distribution along the tube axis, which was calculated by Jia Wang et al 2016 in New J. Phys. 18 023029 (2016). For our calculations, the α electron density in SWCNT for the chiral structures (9,0), (9,2) and (9,3) causes resonant tunneling of electrons through potential barriers. For the chiral structures (9,1), (9,4) and (9,5), we obtain transmission and reflection as same as scattering at a finite potential barrier.

References

[1] Darrick E. Chang, Anders S. SØrensen, Eugene A. Demler and Mikhail D. Lukin , A single-photon transistor using nanoscale surface plasmons, Nature Physics 3 807(2007)
[2] W. Izumida,* A. Vikstrom, and R. Saito , Asymmetric velocities of Dirac particles and Vernier spectrum in metallic single-wall carbon nanotubes, Phys. Rev. B 85, 165430 (2012)
[3] P Srisangyingcharoen1, R Klinkla2 and S Boonchui , Dynamics of propagating surface plasmon
induced photon emission from quantum dots: quantum history approach, J. Phys. B: At. Mol. Opt. Phys. 48, 215501 (2015)
[4] Jia Wang, Wanrun Jiang, Bo Wang, Yang Gao, Zhigang Wang and Rui-Qin Zhang, Chirality dependent spin polarization of carbon nanotubes, New J. Phys. 18 023029 (2016).

Electromagnetic interaction between talcum particle and a topological insulator

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We identify the electromagnetic interaction between talcum particle and surface of topological insulator which unsatisfied ordinary Maxwell's eq. For theoretical calculation, we use the dyadic green function including with the method of an image charge. We describe the electromagnetic response taking into account the property and morphology of surface material such as the dielectric constant and surface roughness of the material [1]. Our numerical results demonstrate the electromagnetic field and the interaction force between talcum and topological insulator which influence to the system [2].

References

[1] J. E. Sipe, Jeff F. Young, J. S. Preston, H. M. van Driel, Phys. Rev B 27, 1141 (1983).
[2] A. Martín-Ruiz, M. Cambiaso, L. F. Urrutia1, Phys. Rev D 94, 085019 (2016).

The material-point method for colloids in liquid rubber foam in the equilibrium state

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We use the material-point method to simulate the model of colloids in liquid rubber foam that each colloid size corresponding to Gaussian distribution and have random position and velocity in the initial condition. By using the material-point method [1], we can simulate interaction and position schematic of colloids in liquid rubber foam evolve by time from the initial state to the equilibrium state [2].

References

[1] Nguyen, Vinh Phu, Technical report, Monash University, Australia (2014),
[2] Xiong Zhang, Zhen Chen, Yan Liu., Academic Press, Pages 37-101, ISBN 9780124077164 (2017)

Effect of polymer and salt concentrations on heterogeneous degradation of chitosan powder by solution plasma

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Solution plasma (SP) has recently become an interesting technique for the degradation of polymers, due to its ability to induce active species under low temperature and atmospheric pressure. The SP can induce the formation of highly active species, which can promote the degradation reaction with low chemical, compared to other conventional methods [1, 2]. Chitosan is one of the promising nature-derived polymers that have been widely studied and used for biomedical applications, especially low molecular weight chitosan (LMWC) and chitooligosaccharides (COS) [3]. To obtain high-quality LMWC and COS, the degradation process plays an important role, therefore, the degradation system should be thoroughly explored, including all influencing parameters. In this work, the effect of polymer and salts concentrations on the heterogeneous degradation of chitosan powder, which was dispersed in the salt solutions [4], via the SP treatment was investigated. The physical structure and particle size of chitosan powder in different sodium chloride concentrations were examined by using scanning electron microscopy (SEM) and particle size analyzer, respectively. Furthermore, the formation and quantitative information of hydroxyl radical, which is an important radical for the degradation of polymers via the SP treatment, in the studied systems were obtained from the optical emission spectroscopy (OES) and fluorescence detection technique, respectively.

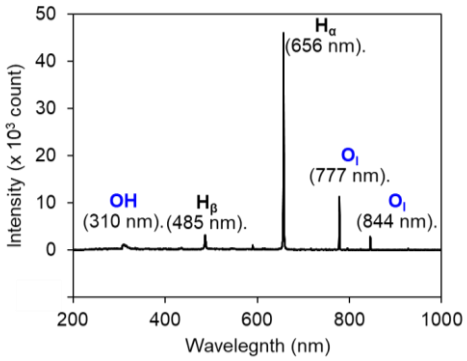

Fig. 1. Formation of highly reactive species via the SP treatment in the aqueous solution of sodium chloride, measured by OES.

References

[1] C. Chokradjaroen, *et al.*, Carbohydr. Polym. 167, 1(2017).
[2] K.M. Vårum, M.H. Ottøy, O. Smidsrød, Carbohydr. Polym. 46(1), 89(2001).
[3] V.K. Mourya, N.N. Inamdar, Y.M. Choudhari, Polym. Sci. Ser. A 53(7), 583(2011).
[4] C. Chokradjaroen, *et al.*, Carbohydr. Polym. 201, 20(2018).

Role of Sn-based and Ti-based catalysts on melt copolymerization of PLA-Polyols

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Polylactic acid or PLA is one of the most interesting biodegradable materials, but unfortunately, it is very brittle and has low impact resistance. Copolymerization of PLA with soft segment such as polyethylene glycol (PEG), polypropylene glycol (PPG) or polycaprolactone (PCL) is a possible solution for improving the toughness of PLA. Ring-opening copolymerization of lactide monomer with other co-monomers is a means of producing PLA copolymer. The reaction could be catalyzed by organometallic catalysts such as stannous octoate, dibutyltin dilaurate or titanium butoxide. The limitations of this process are long reaction time of about 4-8 hr., and requirement of purification and solvent evaporation. The present study aims to prepare PLA-PEG and PLA-PPG copolymers from a high molecular weight PLA resin and the two comonomers using a melt reactive processing approach. The reaction was carried out in a mixer without the presence of solvent. The effects of catalyst types (titanium butoxide (TBT) and dibutyltin dilaurate (DBTL)), types of polyols (PEG and PPG) and reaction time on the chemical structure, molecular weight, and mechanical properties of PLA-based copolymers were investigated. The formation of PLA-PEG and PLA-PPG copolymers was confirmed by ^{1}H-NMR spectroscopy. The results revealed that the molecular weight of PLA-PEG and PLA-PPG were in the range of 5.0 x 10^4 - 1.1 x 10^4 g/mol and 1.1 x 10^5 - 5.5 x 10^4 g/mol, respectively. TBT and DBTL were the effective catalysts for PLA-PEG copolymer. The GPC chromatogram of PLA-PEG copolymer catalyzed by TBT showed unimodal peak at 10 min of reaction time and 20 min of reaction time for DBTL. Increasing reaction times led to the decreasing of molecular weight of PLA copolymer. PLA-PEG and PLA-PPG copolymers were found to strongly enhance the ductility of PLA where the percentage of strain at break of 600 and 200 were resulted, respectively.

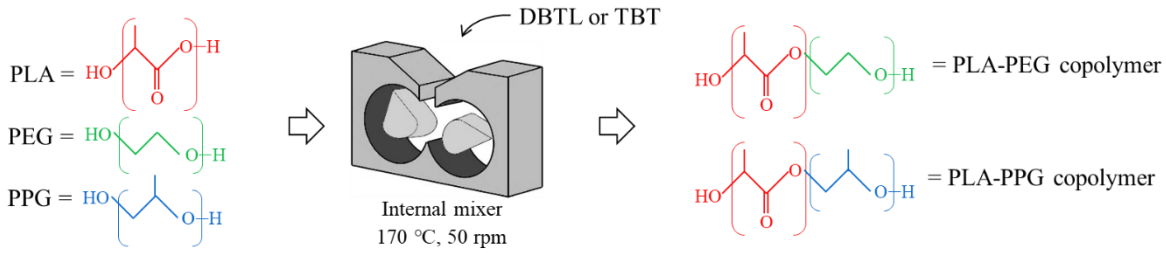

Fig. 1. Schematic of preparation of PLA-based copolymer in molten state.

Preparation of lectin-recognition hydrogel layers on SPR sensor chips by molecular imprinting using carbohydrate ligands

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Molecularly imprinted hydrogel layers with lectin-recognition sites were formed on surface plasmon resonance (SPR) sensor chips via surface-initiated atom transfer radical polymerization (SI-ATRP) combined with molecular imprinting in order to develop SPR sensor systems for sensitively and selectively detecting a target protein. The lectin-imprinted hydrogel layer sensor chips showed larger SPR signal change in response to a target lectin than nonimprinted hydrogel layer sensor chips. It was attributed to the strong affinity constant of the lectin-imprinted hydrogel layer for the target lectin. These results suggest that molecular recognition sites for the lectin were formed within the hydrogel layers by molecular imprinting. On the contrary, the SPR signal change of the lectin-imprinted hydrogel layer chip in the presence of another lectin was very small. Poly (2-methacryloxyethyl phosphorylcholine) as a main chain of the hydrogel layer inhibited nonspecific adsorption of other lectin. The fascinating properties of such molecularly imprinted hydrogel layer sensor chips can provide the useful tools for construct biosensor systems with a wide variety of uses.

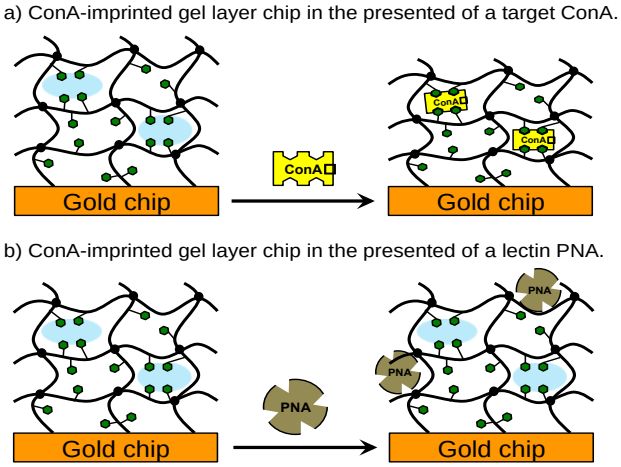

Fig. 1. Tentative representation for lectin-recognition behavior of ConA-imprinted P(MPC-*co*-GEMA) SPR sensor chips in response to ConA (a) and PNA (b) as target lectins.

References

[1] R. Naraprawatphong, G. Kawanaka, M. Hayashi, A. Kawamura, T. Miyata, Mol Impr. 4, 21–30 (2016).
[2] T. Miyata, T. Hayashi, Y. Kuriu, T. Uragami, J Mol Recognit., 25, 336–343 (2012).

Two dimensional crystallization of Bacteriorhodopsin by depletion force.

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Bacteriorhodopsin(bR) is a light-driven proton pump. They penetrate a lipid bilayer. bR can be used as a light response device because bR constructs two-dimensional crystal, namely the purple membrane, in the lipid bilayer. However, the driving force for crystallization is unclear. Here, we assume depletion force as the driving force, and some simple models are calculated. The calculated results are analyzed and they are compared with experimental results. Wild-type bR monomers construct trimers, and the trimers construct a crystal. M.P.Krebs prepared mutant bRs which cannot construct trimer. The mutant bRs construct a crystal, although the mutants cannot construct the trimers. Krebs obtained critical concentration (CC)[1]. Here, CC is defined as the concentration of bR on the low concentration side of the solid- liquid coexistence line (fig.1). They showed that the CC for the mutant monomers is 10.2 times larger than that for the trimer of wild type bR in the experiments. We calculate the CC ratio (CCR) between monomer and trimer by drawing phase diagrams. We modeled bR trimers, monomers, and lipid molecules as a hard disk. That is, the two-dimensional system is adopted as the membrane. In this system, only depletion force works. We prepared a semi-grand canonical system with a reservoir for lipid molecules, and the semi-grand canonical potentials were calculated by using scaled particle theory (SPT) and free volume theory (FVT) to obtain the phase diagrams. The calculated CCR showed good agreement with the experimental one when the packing fraction in the lipid reservoir were adopted. Our results suggest that the depletion force should be important for the bR crystallization.

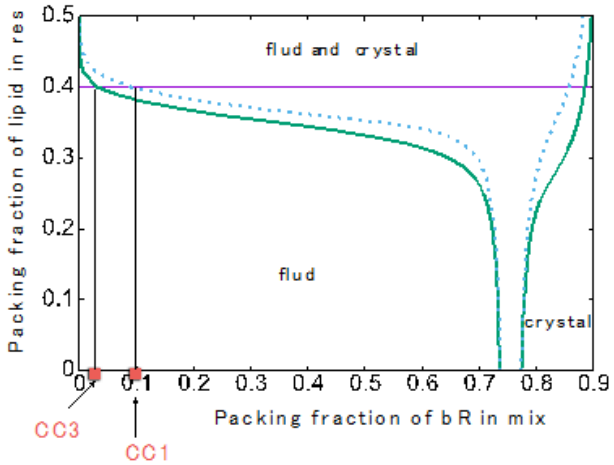

Fig. 1. Phese diagrams of bR trimer (solid line) and monomer (dashed line). Y axis is packing fraction of lipid in the reservoir. X axis is packing fraction of bR. The CC are shown when lipid packing fraction is 0.4.

Reference

[1] T.A. Isenbarger, M.P.Krebs, Biochemistry, 38, 9023 (1999)

Non-destructive assessment of moisture content and modulus of rupture of sawn timber Hevea wood using near infrared spectroscopy technique

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In the year 2017, Thailand has the export value of processed rubber wood up to 50,824.29 million baht [1]. Before exporting to foreign countries, the quality of wood must be inspected [2]. Currently, the sawmill does not have equipment that can check both moisture and strength of the wood without destroying the sample. The objective of this research was to build a prediction model of moisture content and modulus of rupture of sawn timber Hevea wood samples by desktop near infrared spectrometer. The timber samples were collected from the southern region and eastern region of Thailand and scanned using Fourier transform near infrared (FT-NIR) spectrometer in a range of 12489–3594 cm^{-1} (800-2700 nm) in diffuse reflectance mode. Then they were determined for moisture content and modulus of rupture (MOR) following ASTM D143 [3]. The predictive models were built by the partial least squares regression (PLSR). The result showed high performance in prediction of moisture content with correlation coefficient of prediction, R_p = 0.96 and root mean square error of prediction; RMSEP = 4.63%db. Regarding a predictive model of modulus of rupture, the results showed fair performance giving R_p = 0.69 and RMSEP = 18.13 MPa. Therefore, using near-infrared spectroscopy technique to predict the moisture content and strength based on the modulus of rupture of timber Hevea wood offered a rapid and non-destructive measurement as an alternative to destructive checking the quality of sawn timber Hevea wood.

References

[1] Rubber Intelligence Unit. 2017. Export statistics of rubber wood products. Available at: http://rubber.oie.go.th/ImExThaiByProduct.aspx?pt=ex&hgid=4. Accessed on 1 Febuary 2018.
[2] Thai Industrial Standards Institute. 2009. Timber Hevea Wood. TISI. 2423-2552.
[3] American Society for Testing and Materials. 2000. Standard Test Methods for Small Clear Specimens of Timber. D 143-94.

An accelerated biodegradation of Poly (lactic acid) by inoculation of *Pseudomonas geniculate* WS3 combined with nutrient addition

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Polylactic acid (PLA) has been intensively used, especially in form of single-use biodegradable products and PLA biodegradation is relatively slow because PLA-degrading microorganisms in the environment are limited. Therefore, this study aims to develop an efficient method for accelerating biodegradation of PLA. A combined use of PLA-degrading bacterium, *Pseudomonas geniculate* WS3 and nitrogen source or enzyme inducer to accelerate biodegradation of PLA was studied. PLA films were prepared and submerged in basal salt medium (BSM) amended with ammonium sulfate, soytone, sericin or sodium lactate and inoculated with *P. geniculate* WS3 for 30 days. The results showed that the highest percentage of PLA film-weight loss was found in the treatment of soytone addition, followed by sodium lactate addition. PLA films in culture broth with *P. geniculate* WS3 and soytone were cracked and broken down into small fragments within 20 days. In addition, increasing lactic acid content as a monomer of PLA in culture broth was directly correlated with increasing percentage of PLA film-weight loss. It was concluded that a combined use of *P. geniculate* WS3 and soytone exhibited a high potential to accelerate the PLA biodegradation under the submerged condition.

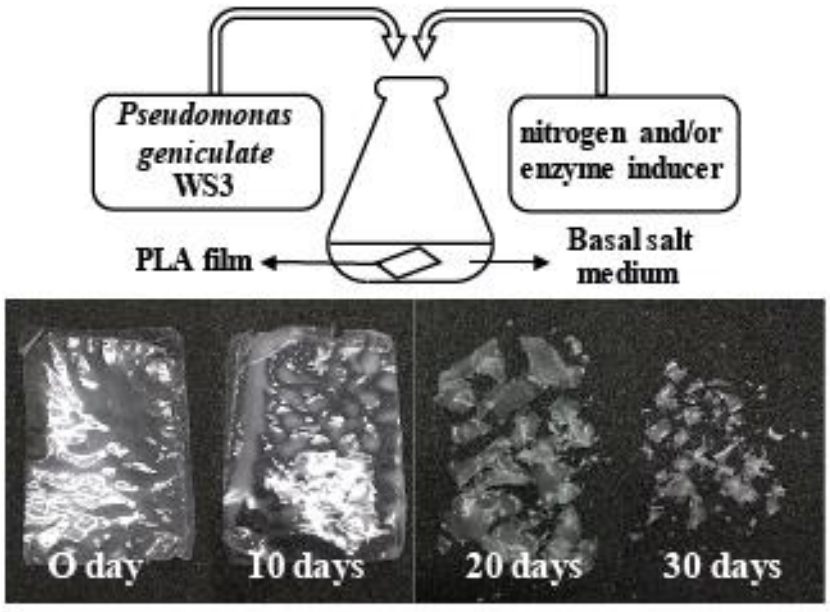

Fig. 1. Graphical abstract of Accelerating biodegradation of Poly (lactic acid) by inoculation of *Pseudomonas geniculate* WS3 combined with nutrient addition

Production of cellulose microfibers from cassava bagasse

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Cassava bagasse (CB) is waste from starch industry which contains a considerable amount of starch and cellulose. The aim of this study was to extract cellulose microfibers from CB using bleaching treatment and to characterize properties of each fiber in different processing stages. The results showed that the cellulose content of bleached fibers was increased while the non-cellulosic materials decreased. The chemical structure of fibers was determined by Fourier transform infrared (FTIR) spectroscopy, which revealed the dominant peaks related to cellulose microfibers and confirmed the removal of non-cellulosic materials during bleaching process. The surface morphology of fibers was analyzed by scanning electron microscopy (SEM), which exhibited the rough surface due to the removal of starch and non-cellulosic component. The crystalline structure of fibers was analyzed by X-ray diffraction (XRD), the bleached fibers showed the characteristic of cellulose I pattern and presented the higher crystallinity index more than untreated CB, because the amorphous structure was removed during extraction process. It can be concluded that the CB can be used as the new cellulose source.

Extraction of lignin-containing cellulose nanocrystals from sugarcane bagasse

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In this study, sugarcane bagasse (SCB) was utilized as a source for producing cellulose nanocrystals (CNC) and lignin-containing cellulose nanocrystals (L-CNC). In order to obtaining the L-CNC, SCB was pretreated by steam-explosion at 1.3 MPa (190 °C) for 15 min and then directly hydrolyzed by using 60% (w/v) sulfuric acid at 45 °C for 75 min whereas for CNC, the steam-exploded fibers were bleached prior to acid hydrolysis at the same condition. Transmission electron microscopy (TEM) illustrated that the steam-exploded fibers produced L-CNC with shorter length but similar diameter to CNC. This is perhaps due to the less aggregation of the higher amount of lignin in steam-exploded fibers enhanced acid hydrolysis severity to result in shorter length of the L-CNC. Chemical compositions analysis and Fourier-transform infrared (FTIR) spectra were revealed the retaining of lignin in L-CNC after the acid hydrolysis, while the lignin in CNC was almost completely removed. Moreover, the energy-dispersive x-ray diffraction (EDX) showed the sulfate contents on surface nanoparticles of L-CNC around 0.18%, which slightly lower than that of CNC at 0.22% due to the presence of lignin in L-CNC protected cellulose from sulphonation during the sulfuric acid hydrolysis. However, these results demonstrated that the L-CNC could be extracted from SCB without need of bleaching process and will be apply for certain applications in polymeric nanocomposites.

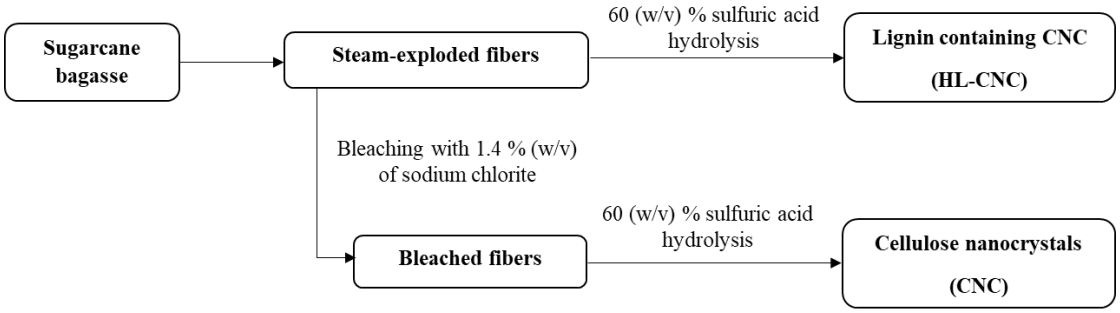

Fig. 1. Shematic representation of the extraction of lignin-containing cellulose nanocrystals from sugarcane bagasse.

Cellulose nanocrystals isolation and application in painting

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The aim of this study was to isolate cellulose nanocrystals (CNCs) from sugarcane bagasse (SCB) and to study its application in painting. Fourier-transform infrared spectroscopy (FTIR) result confirmed the removal of hemicellulose and lignin of SCB through the alkaline and bleaching treatments. The atomic force microscopy (AFM) and Transmission electron microscope (TEM) results showed the diameter of SCB fibers were reduced after the hydrolysis reaction, resulting in CNCs with rod-like shape. Moreover, we mixed watercolor with CNCs and compared to traditional watercolor. The result showed that CNCs did not affect the shade of watercolor when it was mixed with watercolor. The scanning electron microscopy (SEM) results demonstrated that the morphology of watercolor mixed with CNCs after painting on paper has better dispersion characteristics on paper surface than traditional watercolor. Therefore, the isolated CNCs from SCB may be considered as a potential biomaterial for painting application.

Production of calcium hydroxide from sugar industry

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The waste from clarification step of sugar production is filter cake, which is composed of calcium and other minerals which are essential for various applications. Therefore, the aim of this study is to produce calcium hydroxide from filter cake by using calcination method. The sample was calcined at 800 ˚C for 2 hours. The chemical composition and physical characteristics were analyzed with the x-ray powder diffraction (XRD), energy-dispersive spectroscopy (EDS) and scanning electron microscope (SEM). The SEM result showed the formation of calcium hydroxide with morphology similar to commercial calcium hydroxide. The EDS analysis showed the presence of calcium and oxygen in the powdered sample. XRD analysis showed the fingerprint of calcium hydroxide which confirmed the calcined material is calcium hydroxide. Therefore, filter cake from sugar industry could serve as a raw material for calcium hydroxide production.

The effect of Lactobacillus plantarum on cellulose extraction

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Ensiling as pretreatment of sugarcane bagasse for extraction of cellulose with Lactobacillus plantarum was examined. Sugarcane bagasse was also sieved under 40 mesh with no additive as control (CT) and L. plantarum (L) was used in controlled condition for 24 hours before bleaching. The morphology and physiochemical properties of the fibers obtained after treatment were characterized by scanning electron microscopy (SEM), Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD). The results showed that L. plantarum produced organic acids to break down some components of hemicellulose and lignin. Treating the sugarcane bagasse with L. plantarum reduced the amount of sodium chlorite dosage for bleaching relative to the control. Sugarcane bagasse ensiled with L. plantarum increased the efficiency for cellulose extraction.

The study of a small-sized Thai chili paste supply chain

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The highly competitive lifestyle results in the increasing demand for ready to eat food. In Thailand, chili paste is a traditional food that has been passed down from generation to generation. It plays an important role in Thai meals and becomes more popular in convenience stores and hypermarkets. The objectives of this study are to explore the current supply chain of a small-sized Thai chili paste enterprise, to analyze the business processes and identify the problem and provide the recommendation for improvement. First, we observe and perform an in-depth interview of the owner and staff for realizing the business process. Then, the result is analyzed by using the Integration Definition for Function Modeling (IDEF0) to show the existing stakeholders and current key activities in Thai chili paste. The major problems are lack of data collection, low forecast accuracy, lack of inventory management, and low productivity. The proper controls are proposed. Finally, our guidelines could enhance the productivity of other small-sized enterprises which can increase the potential capability for domestic and international markets.

References

[1] Seubsman S -A, Suttinan P, Dixon J, Banwell C 2009 Thai meals *Meals in Science and Practice* 413-451.
[2] Chaveesuk R and Jitareetep C 2017 Chili Paste Culture in Bangkok Metropolis *The 3rd International Conference on Agro-Industry 2016 "Competitive & Sustainable Agro-Industry: Value Creation in Agribusiness"* KnE Life Sciences 136-145.
[3] https://www.sme.go.th/en/download.php?modulekey=94; November 2019.
[4] https://www.sme.go.th/upload/mod_download/download-20190909103733.pdf; November 2019
[5] Prasertwattanakul Y and Ongkunaruk P 2016 The Improvement of a Thai Organic Rice Supply Chain: A case Study of a Community Enterprise *International Conference on Agro-Industry 2015* KnE Life Sciences 156-160.
[6] Ongkunaruk P 2015 Business Process Analysis and Improvement for a Raw Milk Collection Centre in Thailand *Agriculture and Agricultural Science Procedia* **3** 35-9.
[7] Prasertwattanakul Y and Ongkunaruk P 2018 The analysis of a vertically integrated organic rice company: a case study in Thailand *International Food Research Journal* **25(2)** 481-6.
[8] Yupensuk W and Ongkunaruk P 2017 Business Process Analysis: A case of primary shrimp process *The 3rd International Conference on Agro-Industry 2016 "Competitive & Sustainable Agro-Industry: Value Creation in Agribusiness"* KnE Life Sciences 162-169.
[9] Pradita S P and Ongkunaruk P 2019 Business Process Analysis and Improvement for a Third Party Logistics Provider in Indonesian Cold Chain Logistics *IOP Conf. Ser.: Mater. Sci. Eng.* **526** 012004.

The analysis of a chilled beef supply chain for developing strategic improvement

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The growth of population and economics are factors that affect the increasing demand for livestock products in Indonesia. Beef and chicken are the most consumed meat in Indonesia with an average meat consumption of 2.72 kg per capita per year and there is an increasing trend. Currently, the domestic production of beef is only about 45% percent of the demand, the rest of the demand will be fulfilled by importing live cattle and frozen meat, mainly from Australia. The beef supply chain is quite complex and long. The available infrastructures still need to be improved in order to deliver the beef quickly and handled under appropriate cold chain. Our objectives are to identify the business process of the abattoir in the chilled beef product cold chain, to analyze the problem, and to propose some recommendations for their strategic improvement. The observation and in-depth interviews are conducted. Then, the result is analyzed by using Integration Definition for Function Modelling (IDEF0) to figure out the current situation and the activities in the abattoir. Based on the result, it is found that inventory management and temperature controlling are the major issues in the chilled beef cold chain that need to be monitored and controlled. This suggestion would be able to improve the efficiency of a chilled beef cold chain in Indonesia.

The improvement of the high value-added supply chain: a cordyceps beverage case study

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A healthy food trend is becoming popular which makes people become more aware of taking care of themselves. This causes the growth of healthy business phenomena such as supplements and herb in Thailand. Cordyceps which is known as "winter worm summer grass" is a famous Chinese herbal medicine and very expensive because it is rare. People believe that it provides benefits for enhancing health and boosting energy. Today Thai farmers and entrepreneurs can cultivate cordyceps by themselves resulting in widespread use and lower the price. The objective of this research is to analyze a cordyceps beverage supply chain of a small-sized entrepreneur using Integration Definition for Function Modeling (IDEF0). It explains the overall flow of business and related activity of cordyceps beverage. Then we conduct an analysis of the current problems and recommend how to improve the efficiency of the supply chain. Currently, there is a lack of systematic data collection, no proper KPI and inventory policy and low forecast accuracy. We recommend the entrepreneur to use the spreadsheet for forecasting and record data, create KPI to evaluate performance, set standard and target. Establish an inventory policy to manage material and evaluate supplier's performance. We hope our research will promote the entrepreneur to stay competitive in the dynamic market.

References

[1] FiBL & IFOAM Organics International 2019 *the World of Org. Agr. Stat. & Emerg. Trends 2019* 187-205
[2] Tapingkae T 2018 *Cordyceps Mushroom Cultivation* ed Na Songkhla P (Nonthaburi: Kehakaset)
[3] Ongkunaruk P and Prawat R 2011 *21st Int. Conf. Flex. Autom. Int. Manuf. (FAIM2011)* 1-6
[4] Teerada K and Ongkunaruk P 2015 *KnE Life Sci.* **3**(3) 1-5
[5] Ongkunaruk P 2015 *Agric. Agric. Sci. Proc.* **3** 35-9.
[6] Colquhoun G J., Baines R W. and Crossley R 1993 *Int. J. Comp. Integ. M.* **6**(4) 252-64
[7] Pradita S P and Ongkunaruk P 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **526** 012004
[8] Prasertwattanakul Y and Ongkunaruk P 2018 *Int. Food Res. J.* **25**(2) 481-6
[9] Cai J, Liu X, Xiao Z and Liu J 2008 *Decis. Support Syst.* **46** 512–21

Design approach using finite element method with 3D printing validation

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Rubber forming using traditional molding processes can be given an expensive cost and time-consuming. Although the Finite Element Method (FEM) can be carried out to solve that problem, the mistakes may occurred due to complex part geometry in the practical operation. Certainly, it affected directly to the mold improvement cost. This work introduced the novel method for molded part design. The utilizing of 3-Dimensional (3D) printing technology coupled with the FEM was presented. The concept of this work started with forming the rubber-like material by using 3D printer. The constitutive model and optimized conditions of FEM were then selected. In the next step, part geometry simulation was analysed and compared with experimental data. The result showed that 3D printing techniques had significant effects to the stress-strain behavior. The initial friction was also found to be influenced to the numerical results. The result of part geometry with constant volume showed different solutions. It can be concluded that the part without insert for mold producing are appropriated for the next step designed with the actual material. The introduced method indicated that complicated parts of the product, which led to high cost in design and manufacturing of mold, was effectively eliminated.

Impact absorbing kneepad prepared from natural rubber

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Global status report on road safety in 2018 by World Health Organization (WHO) shows that the number of annual road traffic deaths ranks Thailand as the first country in Asia. Particularly ratio of the motorcycle accidents in Thailand is the third most lethal in the world (74.4% of the road traffic deaths in Thailand), the government and the relating parties will then give especially care. Nowadays personal protective equipment (PPE), with impact absorption or energy dissipation characteristics, must be imported and has high costs. This research then aims to study and develop an impact absorbing material prepared from natural rubber, in order to encourage the competition of Thailand in the global market as well as add the rubber values. The research has been divided in two parts. The first part shows the development of new dilatant fluid with additive, which is more practical in manufacturing point of view due to significant lower viscosity (8,000 cP) compared to the conventional dilatant fluid (110,000 cP). The new dilatant has been developed for increasing impact absorption performance of the natural rubber. The second part provides the development of the impact absorbing material and examine its performances, the material was prepared by impregnating natural rubber foam with the dilatant fluid. Experimental results show that the prototype of knee guard (NRI) impregnated with the new dilatant gives good shock impact absorbing performance (higher than 5,000 Newton) with initial impact energy of 10.3 Joules (or initial impact force 7,500 Newton, the new dilatant of 12% by volume of total material). This shows 20 – 30% higher performance than the prototype with the conventional dilatant. In other words, the NRI with the new dilatant and the commercial knee guard (D3o) have transmission force < 2,300 Newton (with CV 1.1% and 1.5% respectively), while the NRI with the conventional dilatant has the transmission force < 3,500 Newton (CV 5%). Considering international impact protection standards, the test results achieved by Thailand automotive institute, Bang Poo Industrial Estate, Samutprakarn province show that the NRI with the new dilatant is corresponding with level 2 class C of the protection standard for roller sports (EN 14120:2003) with the transmission force only 3,933 Newton (< 6,000 Newton) by testing at initial impact energy 25 Joules. It is also coincident with the protection standard for Motorcyclist' protective clothing against mechanical impact (EN 1621-1:2010) with the transmission force only 14,476 Newton (< 35,000 Newton) by testing at initial impact energy 50 Joules. In addition, the impact absorbing material prepared from natural rubber has performance within level 1 of EN 1621-2:2003 standard (peak transmission force < 18,000 Newton), but the commercial knee guard (D3o) passes level 2 of EN 1621-2:2003 standard (peak transmission force < 9,000 Newton). It can be seen that the performance of the natural material is comparable with the commercial one, it also has lower manufacturing cost than 300 THB/piece while the commercial has sale cost of 2,500 THB/piece.

A new internal stress control drying technique of rubberwood lumber

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This research developed an effective drying technique and a control system to prevent checking by using the feedback of the internal stress developed within lumber during kiln drying. The sign and magnitude of the internal stress were continuously monitored with the use of the restoring force technique [1]. In a first drying period, before a reversal of the internal stress, the relative humidity of the air inside the kiln was controlled according to the restoring force value (P) specified (Fig. 1). The drying of 30-80 mm thick rubberwood lumber showed that in order to maintain the restoring force value during the first drying period to a lower negative level, a higher relative humidity of the air inside the kiln was required. A higher level of the negative restoring force caused the stress to be reversed faster and increased the positive maximum restoring force value after the stress reversal. The lumber thickness also affected the reversal of stress in the wood, in which the stress reversal occurred earlier and faster in thinner lumber but the maximum negative restoring force before the reversal was greater in the thicker lumber.

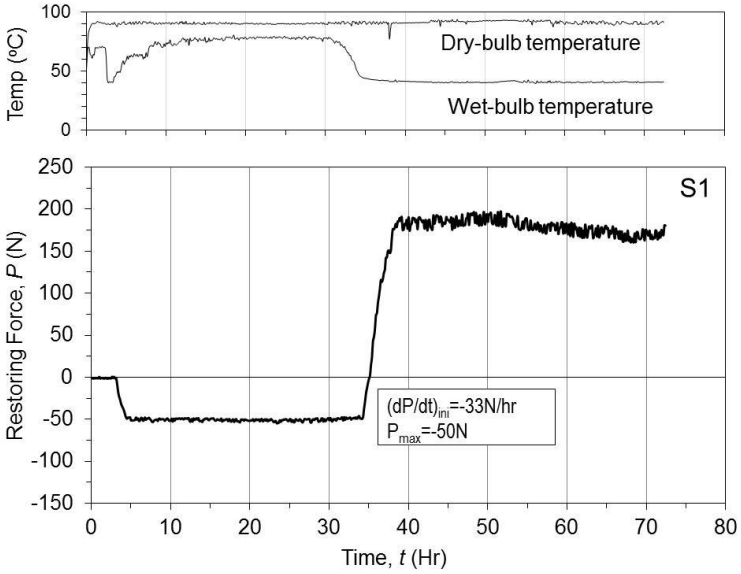

Fig. 1. Control of the restoring force rate at -33N/hr and the maximum negative restoring force at -50N at the drying temperature of 90°C by automatically adjusting the air wet-bulb temperature.

References

[1] P. Diawanich, N. Matan, B. Kyokong, European Journal of Wood and Wood Product 68(1): 1-12 (2010)

A development of automatic builder machine for retreaded tire manufacturing

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Tread building is one of process in tire retreading. That used buffing tire to build from new tread. Building process is required expertise staff because most builder machine requires staff to work with machine any point of process. For this reason, it is difficult to control processing time and the quality of the tire. The objective of this research is to develop an automatic builder machine in retreaded tire manufacturing which are available with a variety of sizes of rubber tires and reduce staff to work. The results of this research are composed of the design and installation of automatic tire loading system, tread loading system, tire rotating and tire pressing system. The results showed that building cycle time of propose automatic builder machine is average 8 minutes per tire and give a good repeatability. Another advantage of proposed system was related with consistent quality. It also affects to the number of worker to fewer operated. And since it is produced by automated system that can transmit the production information to next operation and can support production in Thailand 4.0 way.

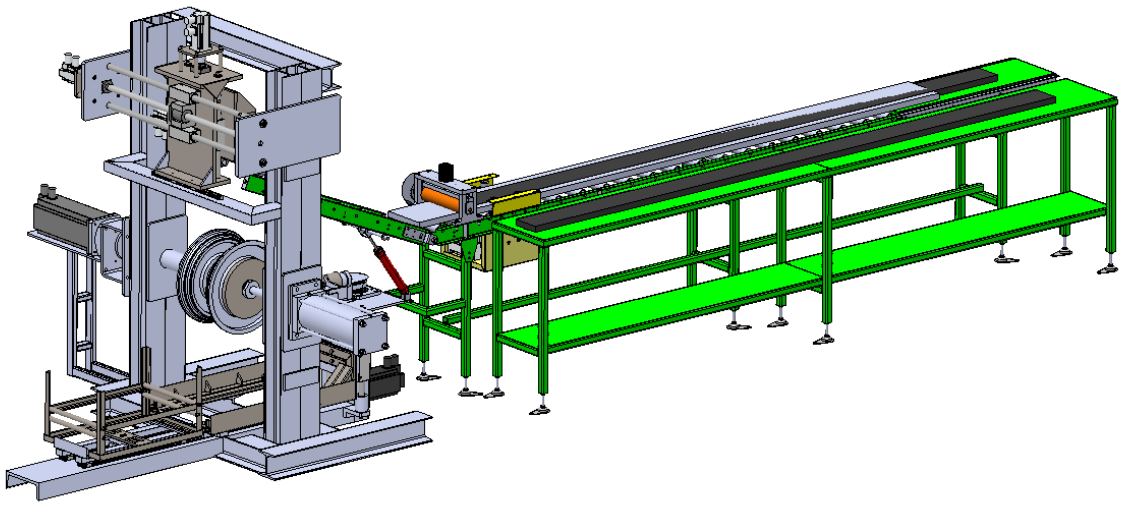

Fig. 1. Automatic Builder Machine.

Application of Kawabata evaluation system for the tactile properties of woven silk fabrics in textile industry

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Thailand is one of the countries well known for their silk fabric production. However, there are just few studies focusing on tactile properties of silk fabrics. This study collected forty-one machined-woven silk fabrics manufactured in Thailand, Japan, China, Korea, Italy, France, India and USA. The fabrics were classified into 4 groups categorized by the fabric weight according to the "silk fabric" industrial product standard of the Thai Industrial Standards Institute (TISI) 176-2540 ($\leq$ 90 g/m^2, 91-120 g/m^2, 121-160 g/m^2, >160 g/m^2). Mechanical properties of the silk fabrics were measured by the Kawabata evaluation system for fabric (KES-F). Correlations between fabric weight groups were analyzed to investigate the relationship among properties. The results showed non-significant effect of the fabric weight (per unit area) on the properties except for the thickness. The thickness was also correlated with the compression properties (WC, RC), the bending rigidity (B) of the warp direction and the surface roughness (SMD). Moreover, the air permeability was associated with the coefficient of friction (MIU), the shearing properties (G, 2HG, 2HG5) and the tensile properties of the weft direction (EM, LT, WT). The total hand value (THV) was calculated by using the Kawabata hand evaluations KN-201-LDY for women's thin dress fabric. The fabrics with the THV scores above 4 showed high quality for women's dresses. The principal component analysis (PCA) was conducted to examine the relationship between the mechanical properties and the fabrics. The results showed that the high-quality fabrics were plotted near each other as a group and related to some properties such as the coefficient of friction (MIU), the extensibility (EM), the tensile energy (WT) of the weft direction and the linearity of compression (LC). Finally, the biplot graph of the fabric distribution can be a guideline for a variety of applications. The fabrics for apparels mainly located in the lower-left quadrant while those located in the upper quadrant were appropriate for home textiles.

Mechanical characteristics of airless tire by laboratory testing

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This paper aimed to study the mechanical characteristics of non-pneumatic tire (NPT) or airless tire upon usage and testing. The NPT was recently invented to replace traditional pneumatic tire subjected to specific applications while eliminate the risk of flatten while using or periodically air pressure maintenance. For that purpose, the NPT must exhibit desired tire characteristics such as load carrying capacity, vertical stiffness, contact pressure, and rolling. The tire mechanical characteristics can be observed by mean of experimental tests in laboratory. In this article, the commercial NPT Tweel developed by Michelin was tested using vertical tire testing machine and drum testing machine. The vertical stiffness and footprint were obtained from tire testing machine, which the latter was obtained using the pressure measurement film. The results were then observed and discussed. The vertical stiffness of tested NPT was compared with the estimated value of traditional pneumatic tire, in which the same size and appropriate inflation pressure were used. The rolling characteristic of NPT was observed from drum testing machine. The rolling resistance at various load and rolling speeds and was recorded. In addition, the high speed video camera was set up to capture NPT spoke deformation during rolling, while the image processing technique was used to collect the coordinate of spoke position at various time. The results were discussed and can be useful in development of NPT tire in the near future.

UV-protection property of Eri silk fabric dyed with natural dyes for eco-friendly textiles

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Eri silk (*Samia ricini*) is a wild silk which has been promoted and supported to culture for textile industry in Thailand. Especially for the recent decade, textile industry was interested to develop eri silk for casual eco-friendly textile style with functional properties. This research aims to study UV protection property of eri silk fabric dyed with natural dyes from plant extracts and their washing fastness property. The processes included extracting the colorants from Thai plants i.e. natural indigo, Burma padauk bark, mango leave, etc., cationizing the eri silk fabric with cationizing agent and dyeing with their natural dyes and with a mordant to increase the washing fastness property. Eri silk fabrics were woven by the dyed eri yarn providing an excellent protection (UPF 50+) with a proper shade for making 3 prototype clothing products. The result shows that UPF property of eri silk fabric dyed with Burma padauk bark, Gloden shower seed, Neem bark, Andaman satinwood leave and mordanted with ferrous sulfate presented highest UPF (>100) with good washing fastness. Three prototype products were designed with color matching with natural dyes and fabricated which were hat, scarf and multi-style shawl. The first product, hat, made from the hand-weave fabric comprised of Ne 40/1 eri silk yarn as a warp yarn and Ne 4/1 hand-reel and hand spun eri silk yarn dyed from natural indigo and Burma padauk bark as weft yarns. Second product was scarf which made from Ne 40/1 eri silk yarn as a warp yarn and Ne 4/1 hand-reel eri silk yarn dyed from natural indigo, Burma padauk bark and mango leave as weft yarns. The last product was multi-function shawl which made from Ne 20/2 eri yarn as a warp yarn and Ne 4/1 hand-reel eri yarn that dyed from indigo and mango leave as weft yarns. These eco-friendly eri silk products exhibited excellent functional UV-protection property.

Rubberwood Sawdust Filled Natural Rubber Composites: Effects of Filler Loading and Zinc Oxide Content

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The aim of this work is to investigate the effects of rubberwood sawdust (RWS) and zinc oxide contents on mechanical properties of RWS/natural rubber composites. The curing characteristics of the composites were determined and the composites were vulcanized at 150°C for 10 min and a pressure of 1000 psi using a hot press machine. The properties of the composites such as tension, hardness and morphology were characterized. The increasing additions of RWS in range of 20-100 phr increased the minimum torque (M_L), maximum torque (M_H) and hardness of RWS/natural rubber composites, but tensile strength and elongation at break of the composites decreased. Further, an increment of zinc oxide contents in range of 3-5 phr into the composites slightly affected the M_L, M_H, hardness and tensile properties. Therefore, the addition of zinc oxide 3 phr is recommended to achieve the properties of RWS/natural rubber composites as well as saving cost.

Impact of legislative measures for CESS management in rubber industry

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According to the Article 47 and 48 in the Rubber Authority of Thailand Act B.E. 2558, the Rubber Authority of Thailand, RAOT, is authorized to collect the export tax known as CEES for supporting the agriculturists, preventing smuggling and distorting the rubber price. It is defined as 2 baht/kilogram. From this act, it is argued that its legislative measure may be unrealistic to enforce in world rubber price. Presented in this paper is the impact of legislative measures for CESS management in rubber industry. The in-depth interview was applied to investigate the CESS legislative measures on agriculturists, manufacturers/purchasers and exporters. The results show that the fixed CESS fee influences on the increased export cost. Moreover, the purchasers and exporters put the fixed CESS fee on the agriculturists. It also reports the guidance for developing the CEES legislative measures in rubber industry.

High selectivity ethylene gas sensors for fruit ripening application

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CeO_x-SnO_2 nanocomposite with different compositions (CeO_x: SnO_2) of 0:1, 1:4, 1:3, 1:2 and 1:1 were synthesized via co-precipitation method. The phase, morphology and particles size of as-prepared CeO_x-SnO_2 nanoparticles (NPs) were characterized by X-ray diffraction, field emission scanning electron microscopy and high-resolution transmission electron microscopy. The result revealed that the highly crystalline solid solution phases structure of CeO_x-SnO_2 were formed exhibiting spherical-like morphology with an average particles size of 10 nm and bonding interfaces occurred between CeO_x and SnO_2 NPs. In addition, the elemental composition and chemical states of CeO_x-SnO_2 (NPs) was investigated by X-ray photoelectron spectroscopy and electron dispersive spectroscopy. The sensor properties towards ethylene gas were characterized in terms of response, response times and stability. Gas sensing data showed that the CeO_x-SnO_2 NPs (CeO_x:SnO_2, 1:2) exhibited the maximum response of 78.79% with a short response time of 12 s to 10 ppm ethylene at 350 °C. Additionally, the sensor exhibited response down to the sub-ppm range of 0.3–10 ppm and high stability towards ethylene. Therefore, the sensor based on CeO_x-SnO_2 NPs can be a promising candidate for detection of ethylene gas in the fruit ripeness monitoring application.

High calcium fly ash geopolymer containing natural rubber latex as additive

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This research studied the use of natural rubber latex as an additive in high calcium fly ash geopolymer. The high calcium fly ash geopolymer with natural rubber latex (medium ammonia concentrated latex type) content of 0, 1, 2, 3, 5 and 10 % by weight of fly ash was incorporated in the mixtures. Setting time, workability, absorption, apparent porosity, compressive strength, flexural strength, and surface abrasion resistance were tested. The test resulted shows that the optimum latex content was 1.0 % of fly ash to obtain mortar with improved mechanical properties and a slight reduction in workability, and an increase in setting time.

Y_2BaCuO_5 particle size control via ultrasonication and its effect on bulk $YBa_2Cu_3O_y$ superconductors

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Recently, bulk superconducting materials became popular choice for engineering applications such as high-field magnet systems for medical devices, rotating machine, magnetic bearings, etc., [1]. $YBa_2Cu_3O_y$ (Y-123) is a trending high temperature superconducting material, with a high critical temperature around 77 K. The superconducting performance of bulk $YBa_2Cu_3O_y$ (Y-123) can be dramatically improved by controlling the initially added secondary phase Y_2BaCuO_5 (Y-211) particles and optimizing the processing conditions in the top seeded melt-growth (TSMG) [2,3]. In this work, we employed a low-cost ultrasonication technique to control size of the initially added secondary phase Y-211 particles. The ultrasonication time is varied from 20 to 100 minutes, with a 20 min interval while maintaining constant power of 300W and 20 kHz frequency. We successfully prepared nanometer sized secondary phase Y-211 particles. Melt textured Y-123 bulks (20 mm diameter) were prepared with this refined Y-211. The magnetization measurements exhibited a sharp superconducting transition temperature with $T_{C,onset}$ above 91 K. Critical current density (J_C) and trapped field measured at 77 K exhibited higher value in the bulk prepared with Y-211 ultrasonicated for 100 minutes. The highest trapped field of 0.42 T at 77 K was recorded 0.3 mm above the center of the Y-123 bulk's surface. The critical current density was around 40 kA/cm^2. The present results demonstrate that the performance of bulk Y-123 can be improved by controlling secondary phase Y-211 particle size via a low cost ultrasonication process.

References

[1] J.H. Durrell, M.D. Ainslie, D. Zhou, P. Vanderbemden, T. Bradshaw, S. Speller, M. Filipenko, D.A. Cardwell, Superconductor Science and Technology 31 (10), 103501 (2018)
[2] M. Muralidhar, N. Sakai, M. Jirsa, N.Koshizuka, M. Murakami, Applied Physics Letters 83(24), 5005-5007 (2003)
[3] S. Nariki, N. Sakai, M. Murakami, I. Hirabayashi, Superconductor Science and Technology 17(2), S30-S35 (2004)

Graphene foam filter for $PM_{2.5}$ capture

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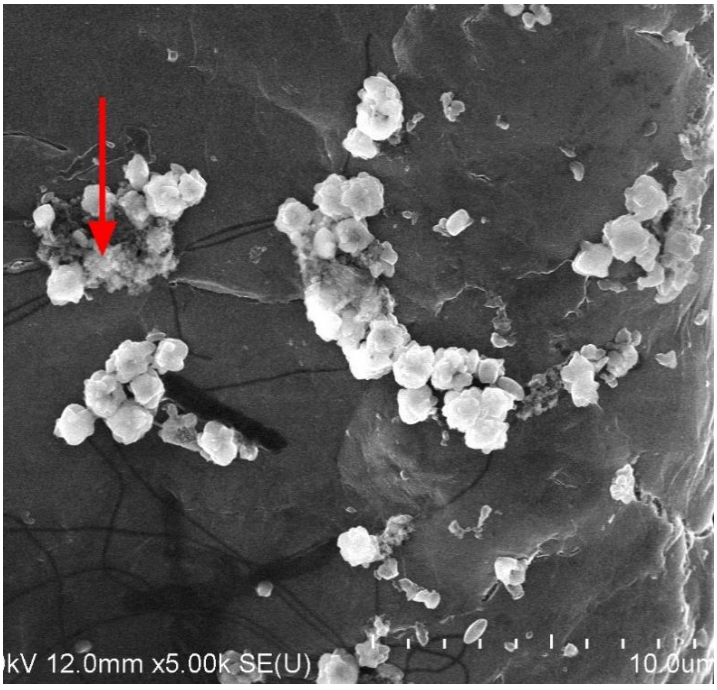
Particulate matter which has diameter of less than 2.5 micrometers ($PM_{2.5}$) has seriously impacted on human health such as chronic respiratory diseases. Graphene foam is a 3-dimensional graphene, in which carbon atoms are arranged into a honeycomb lattice. In this study, $PM_{2.5}$ capture using graphene foam filter is demonstrated. The graphene foam is synthesized by chemical vapor deposition using nickel foam as a template. After that the sample is soaked with $FeCl_3$ to dissolve the nickel foam template. The presence of graphene on nickel foam is confirmed by Raman spectroscopy. The morphologies of graphene foam and $PM_{2.5}$ particles are measured by field emission scanning electron microscope. The element composition of $PM_{2.5}$ is investigated by energy-dispersive X-ray spectroscopy (EDX). Fig. 1 shows a SEM image measured on the surface of graphene foam after testing $PM_{2.5}$ capture. The EDX analysis confirms that the graphene foam can capture $PM_{2.5}$ particles on its surface. Moreover, the EDX results show the $PM_{2.5}$ comprises of Al, Si, P and Cr.



Element	Weight %
C	45.68
O	31.45
Al	0.5
Si	2.49
P	3.48
Cl	0.64
Cr	2.43
Fe	13.34

Fig. 1 (Left) SEM image measured on graphene foam after testing $PM_{2.5}$ capture. (Right) A table shows element composition investigated at the position of red arrow.

Natural rubber human phantom for cancer treatment radiation dose verification of radiation therapy

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Head and neck cancer is the most common form of cancer and is still increasing very rapidly. Radiotherapy is an essential part of the treatment of cancer because it is high efficiency cancer treatment. The use of high dose radiation therapy requires appropriate prescribed dose to ensure the desired accuracy of the dose to the tumor. However, the accuracy of radiation dose has to be verify in a Head and neck human phantom. Consequently, the purpose of this study was to develop an anthropomorphic head and neck phantom for verification of radiation treatment in kead and neck cancer. A mold of the Head and neck phantom was designed as the reference phantom using a fused-deposition-modeling-based 3D printer with Acrylonitrile Butadiene Styrene (ABS) filament. In this research, a formulation of latex rubber was developed to produce this phantom, which was density closely soft tissue. In a subsequent stage, the developed formulation used natural latex rubber with a vulcanizing agent, additives and filler to produce the phantom at appropriates temperature. The results of the radiation resistance testing have shown in terms of the mechanical properties and thermal property. As the result, the Head and neck phantom could be used for dose verification in clinical practice for head and neck cancer treatment planning, as well as the use for dose verification in practical head and neck cancer treatment in radiation therapy. The comparison of percentage dose differences between measured and calculated dose were less than3 %. In conclusion, anthropomorphic head and neck phantom pays an important role for treatment planning dose verification. Additionally, the natural latex rubber can be used to produce medical phantoms perfectly.

POSTER PRESENTATION

Biobased composite from poly (butylene succinate) and peanut shell waste adding maleinized linseed oil

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Nowadays, the biobased plastic products has become one of the worldwide topics that people give the attention. Applications of biobased poly (butylene succinate) (PBS) is interesting since it is fully biodegradable. However, the resin cost is expensive compared to olefins so that it is not widely used. This research attempted to produce cost-effective composite sheets from PBS and peanut shell powder (PSP) with particle size of 100 mesh in the weight ratio of 70/30, 60/40, and 50/50 wt% using a twin-screw extruder and then a compression molding. In addition, maleinized linseed oil (MLO) of 3 phr was used as a compatibilizer for the composites. It was found that the obtained composites had higher Young's modulus and Shore D hardness with respect to the PSP content, but elongation at break was reduced. The impact resistance by means of the falling dart impact test also reduced with the higher PSP content. Adding MLO into the PBS/PSP composites increased elongation at break and impact resistance, but reduced the rigidity due to plasticizing effect. Due to lignocellulosic nature of PSP, the thermal stability of the composites was decreased and MLO did not have significant influence on it. After the weathering testing for 60 hours, mechanical properties and thermal stability of the composites were reduced significantly implying that these biobased composites could degrade faster compared to pure PBS sample.

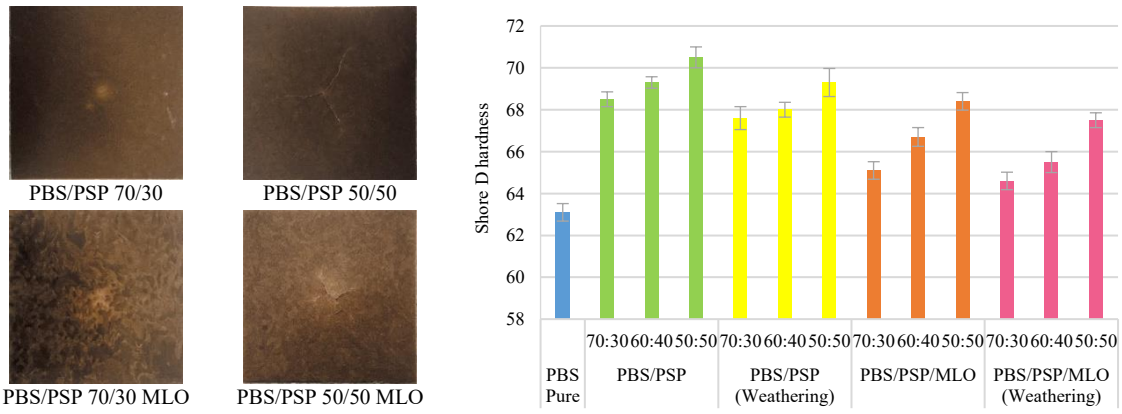

Fig. 1 Images of PBS/PSP composite sheets after the falling dart impact test (left) and the Shore D hardness test of the pure PBS and the PBS/PSP composites before and after weathering (right).

References

[1] Liminana P, Garcia-Sanoguera D, Quiles-Carrillo L, Balart R and Montanes N *Compos Part B-ENG* 2018 **144** 153
[2] Ferri J M, Garcia-Garcia D, Sánchez-Nacher L, Fenollar O and Balart R *Carbohydr Polym* 2016 **147** 60
[3] Cho K, Lee J and Kwon K *J Appl Polym Sci* 2001 **79** 1025
[4] Quiles-Carrillo L, Blanes-Martínez M M, Montanes N, Fenollar O, Torres-Giner S and Balart R *Eur Polym J* 2018 **98** 402

Surface plasmon resonance sensor based on core-shell metal nanorods

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We propose a surface plasmon resonance (SPR) sensor based on core-shell metal nanorod arrays for ultra-sensitive refractive index (RI) sensing applications. The absorptance characteristics are investigated by means of three-dimendional finite element method. The physical origin is explained through the absorptance spectrum, distribution of electric/magnetic field intensities and surface charge density. Simulation results show that the absorptance (A) of the proposed PPA can be reached A=90.00% which is about 3.5 times enhancement compared to its solid counterpart (A=25.57%). Resonance phenomena of SPR, gap plasmon resonance and vertical plasmon resonance induced in the proposed SPR sensor can be simultaneously found in metal surface, gap among Ag nanorods and Fabry-Perot cavities, respectively. The calculated sensitivity can be achieved up to 700.00 nm/RIU (RIU is the refractive index unit). The proposed SPR sensor could be a desirable candidate for applications in the plasmonic sensors and nanophotonic devices.

Chitosan/regenerated silk fibroin films as a biomaterial for daily disposable contact lenses-based ophthalmic drug delivery system

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More than 90% of currently marketed topical eye drops are in the form of solutions and suspensions because of their convenience and ease of administration [1]. Unfortunately, eye drops are notorious for poor ocular bioavailability with less than 5% of administered drugs entering the anterior chamber and reaching the intraocular tissues. Most of drug is lost due to blinking, rapid tear turnover rate and drainage into the nasal cavity [2-3]. In order to overcome this limitation of the low ocular bioavailability, chitosan/regenerated silk fibroin (CS/RSF) films as a biomaterial for contact lenses-based ophthalmic drug delivery system were developed for a prolonged drug release by increasing the residence time of the drug on the ocular surface. CS/RSF films were prepared by using a film casting technique. Their physical properties, cytotoxicity, drug loading and *In vitro* drug release were investigated. At optimal preparation conditions, CS/RSF films showed smooth surface, high visible light transparency, high wettability, high oxygen permeability, good mechanical stabilities, non-degradation and non-cytotoxicity that could meet the required properties of daily disposable contact lenses. Furthermore, diclofenac sodium, a non-steroidal anti-inflammatory drug, can be loaded in CS/RSF films. The prolonged drug release up to 11 h was observed. This indicated that their promising potential use as a biomaterial for daily disposable contact lenses-based ophthalmic drug delivery system.

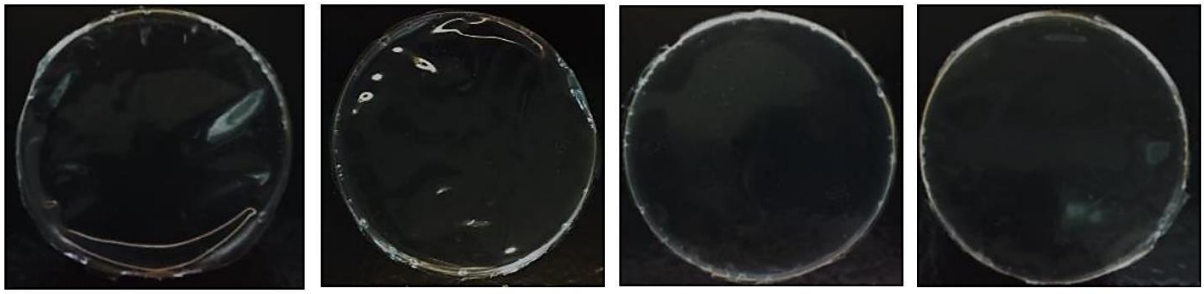

Fig. 1. The appearance of CS/RSF films with different blended ratios

References

[1] CL. Bourlais, et al., Prog. Ret. Eye. Res. 17, 33-58, (1998)
[2] JC. Lang, Adv. Drug. Deliv. Rev. 16, 39-43, (1995)
[3] SG. Deshpande, S. Shirolkar, Pharm. Pharmacol. 41, 197-200, (1989)

The growth of graphene on stainless steel by chemical vapor deposition using soybean oil as a carbon source

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Graphene is a 2-dimension material which consists of carbon atoms arranged in a flat honeycomb lattice. Graphene has many outstanding properties such as high electron mobility, superb strength, transparence and great flexibility. Although graphene film can be fabricated by economical method such as chemical vapor deposition, the utilization of inflammable gases (such as methane, hydrogen and so on) in the graphene growth process is still dangerous. Soybean oil is available vegetable oil which contains carbon, hydrogen and oxygen. Therefore, the utilization of soybean oil as a carbon source instead of hydrocarbon gas for graphene growth by chemical vapor deposition can avoid an explosion of inflammable gas and save the installation cost of gas system especially gas mass flow meters. However, the presence of oxygen in soybean oil may obstruct the growth of graphene by chemical vapor deposition. Fortunately, annealing stainless steel with carbon at high temperature can eliminate oxygen from the surface. In this study, the growth of graphene on stainless steel by chemical vapor deposition using soybean oil as a carbon source has been study. The presence and quality of graphene are investigated by Raman spectroscopy. The morphology and element analysis are measured using electron scanning microscope and energy-dispersive X-ray spectroscopy, respectively.

Facile preparation of magnetic carbon nanofiber composite from *Nata-de-coco* for removal of methylene blue dye from water

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Facile synthesis of 3-dimensional (3D) structured carbon nanofiber composite from *Nata-de-coco* has been demonstrated. *Nata-de-coco*, readily available in the market, was used as a renewable source of carbon, due to its high cellulose content in the form of nanofibers. Fe^{3+} was used within this work as a magnetic particle source and at the same time as a pore activating agent. To prepare the magnetic carbon nanofiber composite, *Nata-de-coco* was freeze-dried, infiltrated with Fe^{3+}solution and subsequently pyrolyzed at 700°C. The resulting composite was then characterized using scanning electron microscope (SEM), surface area and pore size analyzer, X-ray diffractometer and vibrating-sample magnetometer (VSM). The magnetic carbon composite with 3D fibrous and porous structure with high specific surface area of 584 m^2/g was successfully achieved. When used as an adsorbent, the sample can completely adsorb 10 ppm methylene blue dye within 1 minute and can be simply regenerated using ethanol, allowing the sorbent to be reused. Since this sorbent exhibited good magnetic properties, it could be readily separated from aqueous solution by applying an external magnet, making this material practical for use in real system.

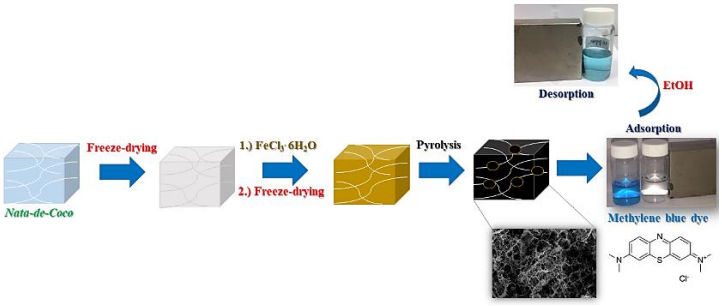

Fig. 1. Illustration of preparation procedure and methylene blue dye adsorption/desorption of magnetic carbon nanofiber composite from *Nata-de-coco*

References

[1] Bai, Q. H., Xiong, Q. C., Li, C., Shen, Y. H., & Uyama, H. (2017). Hierarchical porous cellulose/activated carbon composite monolith for efficient adsorption of dyes. Cellulose, 24(10), 4275-4289.
[2] Hina, K. Z., Zou, H. T., Qian, W., Zuo, D. Y., & Yi, C. H. (2018). Preparation and performance comparison of cellulose-based activated carbon fibres. Cellulose, 25(1), 607-617.

Characterization of polylactic-epoxidized natural rubber/modified cellulosic fiber biocomposites with different silane coupling agents

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A purpose of this research was to investigate a potential of two differently modified cellulosic fibers for applying as reinforcing fillers in polylactic acid (PLA) and modified epoxidized rubber (ENR) base of biocomposites. Coupling agents including 3-(trimethoxysilyl) propyl methacrylate and (3-aminopropyl) trimethoxysilane were used in order to modify cellulosic fibers. These fibers were compounded with PLA-modified ENR (modified by bisphenol A diglycidyl ether) in an internal mixer and fabricated to composite sheets using a compression molding, respectively [1]. The formulations of biocomposites were designed by weight ratio of PLA (85%): modified ENR (5%): the cellulosic fiber (10%). Accordance with the results of mechanical property analysis of their biocomposites, the modifications of cellulosic fibers with both silane types significantly improved flexural, hardness and impact properties of PLA-modified ENR based biocomposites. However, the methacrylate-silane modified cellulosic fiber provided the greatest increase in flexural properties while the amino-silane modified cellulosic fiber resulting in the highest value of hardness and impact resistance of all biocomposites. Oil swelling test of biocomposites was also investigated in this research in order to evaluate its possibility to use under oily environment. After 168 hours of experiment, the amino-silane modified composite exhibited the highest oil absorption among all materials. This result indicated the most improvement of hydrophobicity of modified cellulosic fiber by (3-aminopropyl) trimethoxysilane.

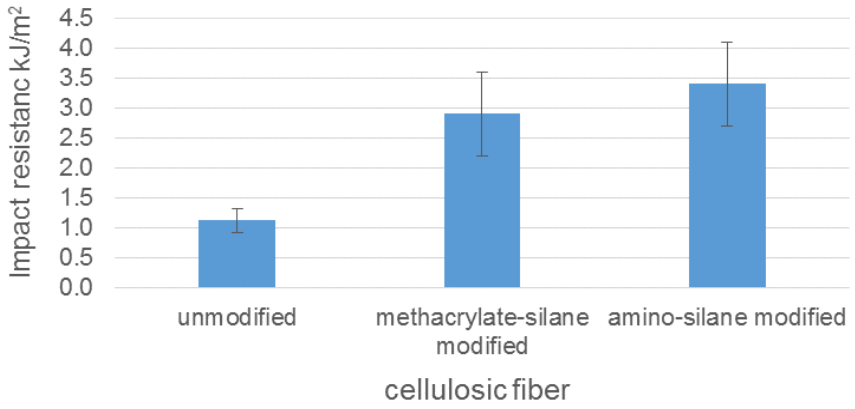

Fig. 1. Effect of modified cellulosic fibers on impact resistance of PLA-modified ENR based biocomposites.

References

[1] U. Meekum, P. Kingchang, Bioresource. 12(3), 5086 (2017).

Effects of post-gamma irradiation on swelling and mechanical properties of gamma vulcanized natural rubber latex (GVNRL) films

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Gamma vulcanized natural rubber latex (GVNRL) films have shown promising properties for various applications that require less hazardous chemicals used or released during manufacturing and/or utilization. Examples of potential applications include the uses as chemical-free latex gloves in medical or food-related facilities and as stretchable latex covers for food and agricultural products. However, due to possible degradation on swelling and mechanical properties of these films from post-gamma irradiation used for sterilization, thorough investigations are required in order to fully understand their possible changes and/or degradations in properties of interest. As a result, this work investigated on effects of post-gamma irradiation on swelling and mechanical properties of natural rubber latex (NRL) films, which were pre-vulcanized using 12-kGy and 24-kGy gamma irradiation. The properties of interest in this work included tensile modulus at 300% elongation, tensile strength, and elongation at break, as well as other related physical properties such as swelling ratios and crosslink densities. The results showed that, for samples before post-gamma irradiation, the GVNRL films with 24-kGy vulcanizing dose had higher tensile modulus, tensile strength, and crosslink density, but lower elongation at break and swelling ratio, than the films with 12-kGy vulcanizing dose. However, after post-gamma irradiation at the accumulated dose of 24 kGy, the films with 12-kGy vulcanizing dose showed significant improvements in the values of tensile modulus, tensile strength, and crosslink density, whereas the films with 24-kGy vulcanizing dose showed noticeably degradation in these properties. Hence, the overall results suggested that, while higher gamma vulcanizing doses could initially produce NRL films with higher mechanical strength, they were more negatively affected by post-gamma irradiation such that mechanical degradation could be observed.

Determination of radioactivities in gamma vulcanized natural rubber latex (GVNRL) for the assessment of radiological safety

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Due to great potentials of utilizing products made from gamma vulcanized natural rubber latex (GVNRL) in applications that require less use or less release of hazardous chemicals during rubber vulcanization, the radiological health risks in rubber producers/users caused by radioactivities from natural radioisotopes containing in GVNRL must be thoroughly determined and evaluated. As a result, this work determined the activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K in GVNRL samples that were vulcanized with 12-kGy and 24-kGy gamma irradiation using gamma spectroscopy. The results showed that the average radioactivity concentrations (± standard deviation) of ^{226}Ra, ^{232}Th, and ^{40}K in 12-kGy (24-kGy) GVNRL were 30.8±1.5 (31.2±2.7) Bq kg^{-1}, 89.1±0.6 (89.7±0.4) Bq kg^{-1}, and 95.4±1.6 (93.2±2.2) Bq kg^{-1}, respectively. These results implied that GVNRL vulcanized with 12-kGy and 24-kGy gamma irradiation had statistically similar radioactivity concentrations and higher gamma doses did not result in increasing radioactivies. Furthermore, when compared these results with the values from non-vulcanized natural rubber latex (NRL), of which the activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K were 29.9±1.2 Bq kg^{-1}, 95.2±1.1 Bq kg^{-1}, and 96.2±1.0 Bq kg^{-1}, respectively, it could be concluded that the use of gamma irradiation for rubber vulcanization did not statistically increase or change activity concentrations of the mentioned radioisotopes, thus, it is radiologically safe for related personnel to work or use GVNRL products.

Facile preparation of monolithic magnetic porous carbon acid catalysts via surface self-assembly method and their applications in conversion of xylose into furfural

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Furfural is a versatile chemical derived from pentosane-rich agricultural and forestry residues. It can be converted to valuable chemicals, for instance, dicarboxylic acid, furfuryl alcohol and tetrahydrofurfuryl alcohol which has broad uses in polymer, rubber, and pharmaceutical applications[1]. The furfural production from xylose, the pentose sugar, was produced through the hydrolysis and subsequent cyclodehydration reaction of xylose sugar catalyzed generally by various catalysts containing SO_3H[2]. Nevertheless, their tedious multi-step preparation and the final catalysts usually in the form of fine powder make them difficult to be separated from the liquid systems after use, leading to time consumption for the industrial scale production. In the this work, novel magnetic porous carbonaceous materials acid catalyst (SO_3H-MPBG) in the form of monoliths have successfully been prepared using sugarcane bagasse as scaffold *via* a self-assembly surface coating method from phloroglucinol/glyoxylic acid precursors with soft-template F127 and Fe^{3+} as a source for magnetic iron particles. Then facile subsequent hydrothermal sulfonation of the as-prepared materials (MPBG) with concentrated H_2SO_4 at 180 °C resulted in magnetic mesoporous carbon bearing SO_3H group (SO_3H-MPBG). The SO_3H-MPBG was characterized by various techniques including XRD, TEM, N_2 sorption analysis, XPS, CHNS elemental analysis, acid-base titration and VSM. A SO_3H-MPBG showed strong magnetism due to the presence of iron magnetic particles and possessed a BET specific surface area of 500 m^2/g. The sample showed acceptable furfural yield when performed at 170 °C using γ-valerolactone (GVL) as a solvent. Besides, the catalyst was easily separated after the catalytic tests using a magnet, confirming its magnetic stability.

References

[1] Y. Zhu, W. Li, Y. Lu, T. Zhang, H. Jameel, H.-m. Chang, L. Ma, Production of furfural from xylose and corn stover catalyzed by a novel porous carbon solid acid in γ-valerolactone, RSC Advances, 7 (2017) 29916-29924.
[2] C. García-Sancho, I. Sádaba, R. Moreno-Tost, J. Mérida-Robles, J. Santamaría-González, M. López-Granados, P. Maireles-Torres, Dehydration of Xylose to Furfural over MCM-41-Supported Niobium-Oxide Catalysts, ChemSusChem, 6 (2013) 635-642.

Surface modification of poly(amidoamine) dendrimer to enhance the anti-proliferative activity

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Acute Lymphoblastic leukemia (ALL) or white blood cell cancer is one of major causes that kills many people worldwide, especially in children [1]. Although various therapeutic agents are available for ALL treatment, the new drug discovery and drug delivery system are needed to improve their effectiveness, to reduce the toxicity and side-effect, and to enhance their selectivity to targeted cancer cells. Poly(amidoamine) (PAMAM) dendrimer is a polymeric spherical nanoparticle that is widely studied in drug delivery system for cancer treatment [2,3]. In this work, we synthesized a PAMAM dendrimer and modified its amino surface groups by conjugating with acetyl moiety, fluorescein isothiocyanate (FITC) and specific peptide [4]. The G5 PAMAM has been successfully synthesized and characterized by NMR and potentiometric titration method. The synthesized G5 PAMAM contains 97.28±0.100 surface amino groups in comparison to 128 theoretical amino groups. The fluorescence binding studies of specific peptide on the PAMAM dendrimer surface found that it is selective to CXCR4 on NALM-6 cell line. Moreover, specific peptide-conjugated G5 PAMAM can inhibit NALM-6 cell migration resulting from blocking of SDF-1α binding to CXCR4. This dendrimer will potentially be able to function as a drug carrier by loading effective drug into its porous structure to improve the drug selectivity to cancer cells.

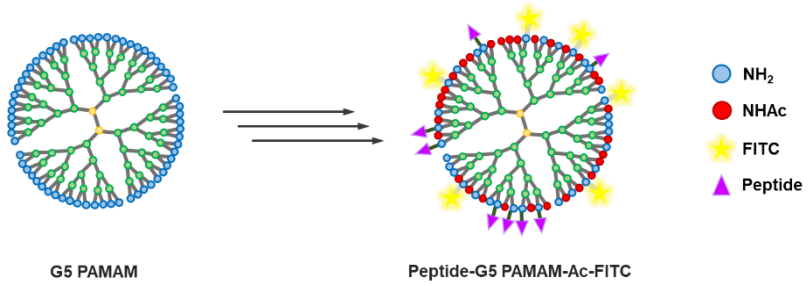

Fig. 1. G5 PAMAM and Surface-modified G5 PAMAM dendrimer.

References

[1] W. Imsamran, *et al.*, Cancer in Thailand. (Vol VIII, 2010-2012). National Cancer Institute, Thailand. (2015)
[2] I.J. Majoros, *et al.*, J. Med. Chem. 48(19), 5892 (2005).
[3] N.T. Pourianazar, *et al.*, J. Nanopart. Res. 16, 2342 (2014).
[4] C. Chittasupho, *et al.*, Eur. J. Pharm. Biopharm. 88(2), 529 (2014).

Preparation and ferroelectric properties of Poly (vinylidene fluoride-hexafluoropropylene) (PVDF-HFP) filled with graphene-nanoplatelets film composites.

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The poly (vinylidene fluoride-co-hexafluoropropylene), PVDF-HFP composite films with addition graphene-nanoplatelets (GPN) was prepared by using the tape casting solution method. The obtained composite films were stretched with help from thermal stretching machine at 80 ºC with 5 mm/min rate. Dielectric constant and hysteresis loop (P-E loop) between the stretching and non-stretching films at different fillers percentage were compared in this study. Dielectric constant was investigated by the LCR meter. The P-E loop was measured by the ferroelectric polarization loop test system. The experimental results showed that the dielectric constant of all samples increases with increasing fillers content, regardless of frequency. The dielectric constant of stretching composite films was higher than non-stretching composite films. In addition, the P-E loop shapes of the stretching films have slimmer than the non-stretching films regardless of filler content. However, the P-E loop produced the shape to be bigger loop with increasing filler content. The energy efficiency of obtained PVDF-HFP composite films will be discussed on their dielectric constant, dielectric loss, AC conductivity, and polarization performances for electric–capacitor materials applications.

Comparative X-ray shielding properties of bismuth oxide/natural rubber composites using a Monte Carlo code of PHITS

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Natural rubber (NR) is the one of potential materials that could be developed as flexible X-ray shielding materials, of which the improvement in the attenuation ability has become one of necessary measures and tools to ensure safety for radiation-related workers and the general public. As a result, this work used the Monte Carlo code of Particle and Heavy Ion Transport System (PHITS) to simulate the X-ray shielding properties of NR composites that were added with Bi_2O_3 particles at different Bi_2O_3 contents (0–50 wt% in 10-wt% increment) and various materials' thickness (2, 4, and 6 cm). The X-ray source used for the simulation was a point source with its energies varied from 0.05 MeV to 0.1, 0.5, 5.0, and 15.0 MeV, respectively, and the detector was assumed to have 100% detection efficiency. The simulated results showed that, at lower energies of X-rays (0.05 and 0.1 MeV), the values of X-ray transmission significantly decreased with increasing filler's contents and materials' thicknesses. However, at higher energies of X-rays (0.5, 5.0, 15.0 MeV), changes in X-ray transmission ratios for different fillers' contents and materials' thicknesses were not as pronounced as in lower-energy X-rays due to the highly penetrating ability of high-energy X-rays. In particular, the highest attenuation ability of the materials obtained in this work was found in NR composites with 50 wt% Bi_2O_3, which had the values of Half Value Layer (HVL), the thickness required to attenuate incoming X-ray intensity by 50%, of 0.2, 0.4, 32.4, 99.0, and 154.0 cm for the X-ray's energies of 0.05, 0.1, 0.5, 5.0, and 15.0 MeV, respectively. Other parameters including the linear attenuation coefficients (μ) and HVL of all filler' contents were also reported and thoroughly discussed in this work.

Effect of zeolite types on properties of polybutylene succinate/polylactic acid films

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This research was to study the effect of modified zeolite using (3-aminopropyl) triethoxysilane in polybutylene succinate (PBS) and polylactic acid (PLA) blend. Two types of modified zeolite i.e., zeolite 5A and 13X at 2 wt% of polymer blend between PBS and PLA were mixed together in twin-screw extruder and thin-films were produced by cast-film extruder. The thickness of each film is between 50 - 70 micron. Mechanical properties, thermal properties, morphological properties and permeability of oxygen, carbon dioxide as well as water vapor were investigated. Adding zeolite 13X into PBS/PLA blend was found to increase more tensile strength with the comparison to zeolite 5A whereas the zeolite type had no effect on the percentage of elongation at break and Young's modulus. The zeolite 5A and 13X tended to increase the thermal stability of composite films. Gas permeation results showed PBS/PLA with zeolite 13X allowed the permeation of carbon dioxide and oxygen more than its counter part of 5A in composite films. Meanwhile water vapor transmission rate of PBS/PLA with zeolite 5A was higher than the one with zeolite 13X.

Apatite inducing ability on silk fabric and its ammonium gas adsorptivity

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Silk fabric contains silk fibroin protein which consists of an amino group. This amino group can act as a nucleation site of hydroxyapatite by inducing the Ca^{2+} ions [1] from surrounding solution at an appropriate pH. To increase the initial Ca^{2+} ions on the surface of silk fabric, the commercial grade silk fabric was drenched in $CaCl_2$ solution for 12 hr, Na_2HPO_4 solution for 20 mins, and $CaCl_2$ for 20 mins, respectively. Finally, the fabric was rinsed by deionized water and the drenching processes were repeated for 7 times in order to increase the inducing ability of hydroxyapatite. XRD patterns showed the phases of hydroxyapatite coexisted with monetite. The sample drenched in $CaCl_2$ over 12 hours gives more apatite peak intensity which is a result of increased Ca^{2+} ions over the surface and dot mapping technique with SEM shows the well distribution of both calcium (Ca) and phosphorus (P) on silk fabric as shown in Fig. 1. It is worth noting that hydroxyapatite induced on the surface of silk fabric can enhance the selectivity in ammonia gas adsorption [2]. An ammonia gas adsorption results in better performance of silk with hydroxyapatite over raw silk fabric were displayed in Fig. 2. These results are promising for development of Thai silk in term of superior ammonia gas adsorption characteristic.

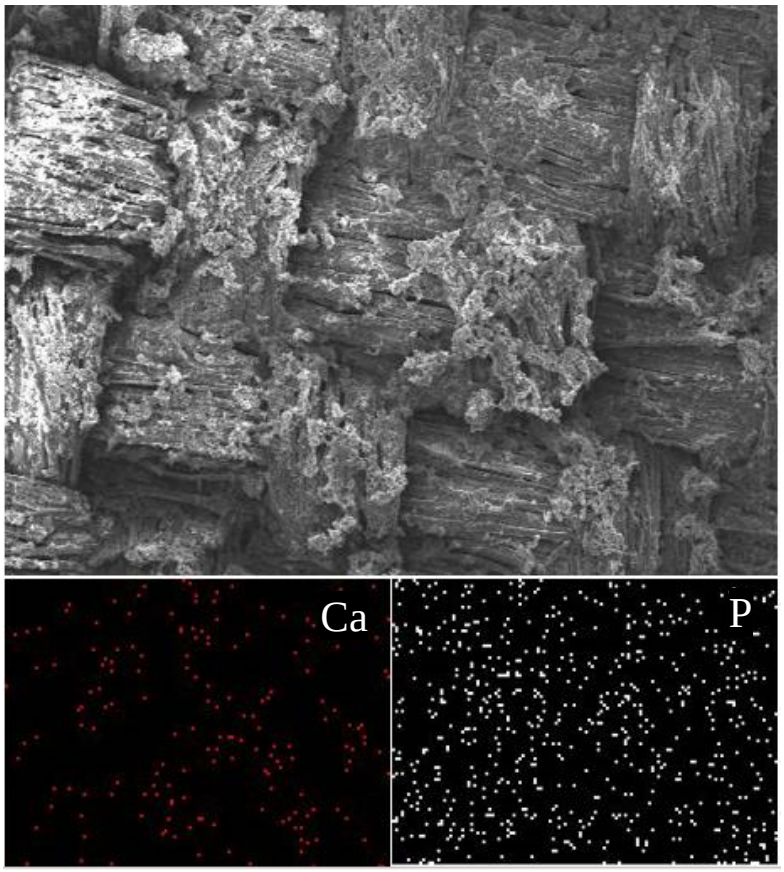

Fig. 1. SEM micrographs showed the hydroxyapatite induced on the silk fabric surface and dot mapping distribution of Ca (left) and P (right)

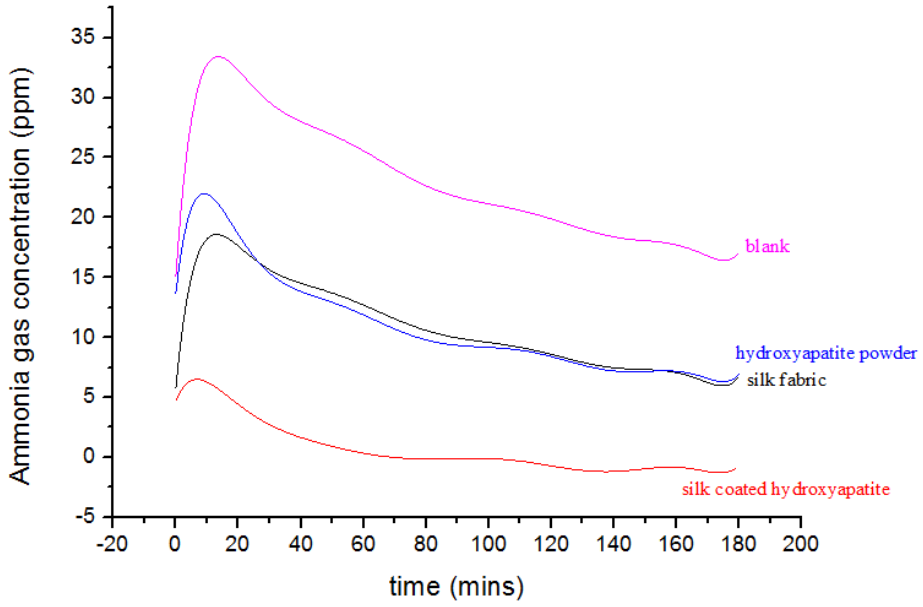

Fig. 2. Ammonia gas adsorption results

References

[1] X.D. Kong, *et al.*, Journal of crystal growth ,(2004): 197-202.
[2] L. Huixia, *et al.*, The royal society of chemistry,(2015): 3865-3874.

Effects of sintering temperature on microstructure of TiO_2 scaffold

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Due to an excellent biocompatibility of titanium dioxide (TiO_2), it is promising to use as scaffolds for inducing bone formation. The well-interconnected pore scaffolds were fabricated by sponge replication method in order to promote osteoblast ingrowth and vascularization. The viscosity of the slurry was adjusted by addition of calcium chloride ($CaCl_2$) which led to more uniformity and densification. The effects of sintering temperatures on microstructure were analyzed by scanning electron microscope (SEM) and microcomputed tomography (Micro-CT). Our experiments showed that the higher sintering temperature increased the grain size and more uniformity of the scaffold. Furthermore, the struts became more rounded and microcracks were not observed which probably correlated to the higher density of scaffold. Thus, it is suggested that optimization of sintering temperatures might allow better control of grain growth and result in more microstructural uniformity.

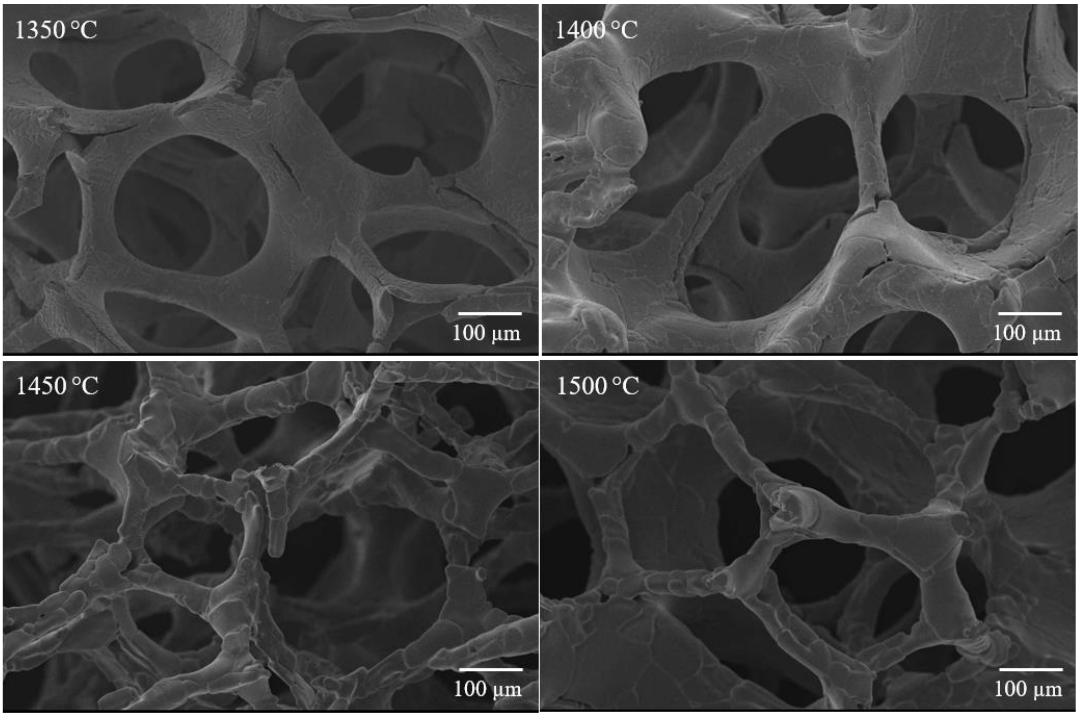

Fig. 1. Effect of sintering temperatures on the microscopic appearance of TiO_2 scaffolds at various sintering temperatures.

References

[1] A. Klemm and H. Tiainen, Cer. Int. 44, (2018).
[2] I. Narkevica, *et al.*, Mat. Sci. App. Chem., (2015).

ZnO-g-C_3N_4-Fe_3O_4 photocatalyst composites embedded polyvinyl alcohol/sodium alginate beads for efficient of photodegradation

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In this research, Fe_3O_4 NPs and g-C_3N_4 nanosheet were synthesized by co-precipitation and the thermal decomposition method, respectively [1,2]. Then ZnO-g-C_3N_4-Fe_3O_4 photocatalyst composites (ZGF) was contained on sodium alginate-polyvinyl alcohol(SA-PVA) beads with different Fe_3O_4 NPs contents of 0(0ZGF), 0.005(5ZGF), 0.025(25ZGF) and 0.075(75ZGF) wt%. Synthesized Fe_3O_4 NPs, g-C_3N_4 nanosheet and ZGF photocatalyst composite were characterized by X-ray diffraction (XRD), Fourier transform infrared (FT-IR), and transmission electron microscopy (TEM). The TEM picture of Fe_3O_4 NPs was showed spherical nanoparticle size around 20 nm and g-C_3N_4 had the nanosheets structure with micropores as shown in Fig. 1. The characterizations demonstrated that the incorporation of g-C_3N_4 improved the pore uniformity of SA-PVA bead and decreased the pore sizes. Kinetic of photocatalytic activity and adsorption were studied by pseudo first order model, pseudo second order model, the Elovich model and the intra particle diffusion model. The results showed that the photocatalytic activity of ZnO sodium alginate-polyvinyl alcohol based composites bead can be improved effectively by the increase g-C_3N_4 and Fe_3O_4 NPs.

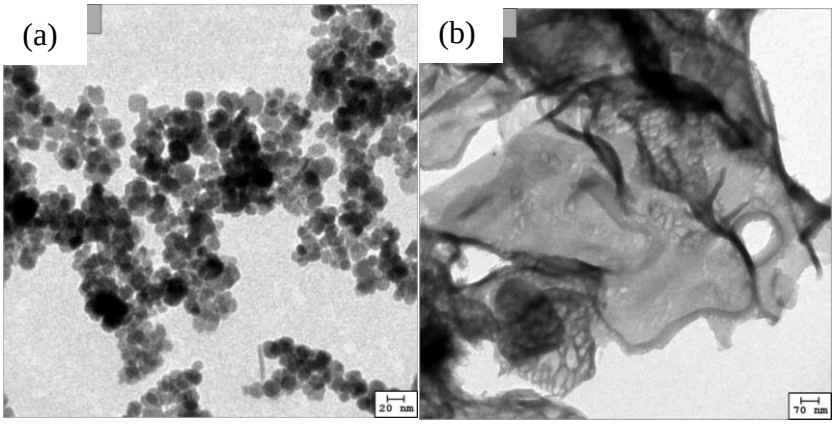

Fig. 1. TEM images of (a) Fe3O4 NPs (b) g-C3N4 nanosheet

References

[1] L. Xiaoshu, *et al.*, J. Hazard. Mater. 262, 748 (2013)
[2] F. Jing, *et al.*, RESULTS PHYS. 11, 331 (2018)

The utilization of wastewater from fermented rice noodle manufacturing process for the production of bacterial cellulose by *Acetobacter xylinim* TISTR 975

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Bacterial cellulose (BC) is a naturally produced as an exopolysaccharide from some bacteria. It has excellent properties over the plant cellulose and has numerous applications in many fields including food, pharmaceutical, textile, paper manufacturing and other industries [1,2]. However, a major limitation of bacterial cellulose use is the high cost of carbon substrate [3]. The aim of this study is to reduce the cost of bacterial cellulose using a cheap carbon source. This study presents feasibility in the production of bacterial cellulose using the starchy effluent waste from the fermented rice noodle manufacturing process as low-cost substrate by *Acetobacter xylinum* TISTR 975. The optimizations of culture conditions for bacterial cellulose production were also investigated under static culture. The result indicated that starchy effluent waste from the fermented rice noodle manufacturing process performs well for the production of bacterial cellulose by supplementing with 5 g/L sucrose and 2% olive oil under the static condition as shown in Fig. 1. Moreover, the structure and physical properties of bacterial cellulose were characterized using SEM, FTIR and XRD. In summary, the use of starchy effluent waste from the fermented rice noodle manufacturing process can be produced bacterial cellulose and make it a high value-added, more cost-effective, sustainable and green product.

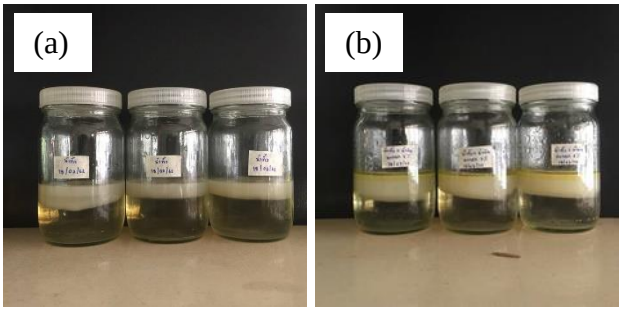

Fig. 1. The production of bacterial cellulose using starchy effluent waste from the fermented rice noodle manufacturing process (a) without and (b) with 2% olive oil.

References

[1] W. Jing, T. Javad, T. Youhong Carbohydr. Polym. 219, 63-76 (2019).
[2] H. Azeredo, *et al.*, Front. Sustain. Food Syst. 3, 1-14 (2019).
[3] Z. Anna, *et al.*, Carbohydr. Polym. 119, 294-303 (2018).

Study of rubber/calcium carbonate composites

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Natural rubber (NR) is a high molar mass polymer which also exhibits high mechanical properties. Fillers have been widely used in the rubber industry for many applications such as tile floor, vehicle tire, etc. Calcium carbonate ($CaCO_3$) is one of the important inorganic powders and it is widely used as filler in order to reduce the cost in rubber industry. The objective of this study is to investigate physical and mechanical properties of the rubber composites with $CaCO_3$ powder. We studied the $CaCO_3$ additive in natural rubber (NR) with 25, 50, 75 and 100 parts per hundred rubber (phr). The effect of $CaCO_3$ on the properties of rubber composite, such as Mooney viscosity, bound rubber, Mullins effect and Payne effect, was investigated. The result of Mullins effect of rubber composite filled with $CaCO_3$ is in good agreement with the result of bound rubber, higher bound rubber higher stress to pull the rubber composites. The Payne effect shows that the value of different storage moduli (ΔG') of rubber compound filled with 25 phr $CaCO_3$ is the lowest due to weaker filler network. While, the NR supplemented with 100 phr $CaCO_3$ represents more significant ΔG' with the strain increasing. This type of material could be applied for tailoring the properties of rubber products.

The effect of hydroxylamine sulfide on the storage hardening of natural rubber

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Natural Rubber (NR) consists of rubber and non-rubber components, the NR chain is mostly *cis*-1,4-polyisoprene. The main non-rubber components are proteins and phospholipids which are attached at each end chain of NR. If we keep prolong storage of NR, the proteins and phospholipids of NR chain help create a NR network. This causes the gel formation within NR which increases its Mooney viscosity, this phenomenon is called the storage hardening. The objective of this work is to study the effect of hydroxylamine sulfide on the storage hardening of natural rubber. Three types of natural rubber sample were prepared: NR without hydroxylamine sulfide, NR with 0.2 phr of hydroxylamine sulfide, and NR with 2.0 phr of hydroxylamine sulfide. NR samples are characterized for 0 and 12 weeks of storage at room temperature. We found that gel content and Mooney viscosity of NR without hydroxylamine sulfide are increased with the storage hardening for 12 weeks. However, both NR samples with hydroxylamine sulfide represent constant values because hydroxylamine sulfide inhibits the network and the gel formation of NR. The non-rubber components in NR, in particular proteins and phospholipids, affect the storage hardening of NR. The stabilization of NR properties as a function of time is required by rubber industry.

References

1. Chollakup, R., Suwanruji, P., Tantatherdtam, R., and Smitthipong, W. 2019. New approach on structure-property relationships of stabilized natural rubbers. **Journal of Polymer Research**. 26:37.

2. Liu, J., Wu, S., Tang, Z., Lin, T., Guo, B., and Huang, G. 2015. New evidence disclosed for networking in natural rubber by dielectric relaxation spectroscopy. **Soft Matter**. 11(11): 2290–2299.

The effect of non-rubber components on mechanical properties of TESPD silane coupling agent in silica-filled rubber compounds

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Silica is reinforcing filler with high polarity, leading to the difficult to get the homogenous mixing with a natural rubber (NR) compound, which normally becomes silica agglomeration. A silane coupling agent is applied in a silica-filled NR compound in order to enhance compatibility between silica and rubber. Moreover, non-rubber components, especially proteins, believe to have competition with silane coupling agent during a silanization [1, 2]. In this work, the interaction between the silane coupling agent and silica-filled NR materials was investigated to show the components influenced in filler-filler and filler-rubber interaction as well as mechanical properties. The rubber types with different non-rubber components such as fresh NR, deproteinized NR (DPNR) and polyisoprene rubber (IR), absence of non-rubber constituents were mixed with *bis*-triethoxysilylpropyl disulfide (TESPD) and silica by using an internal mixer at high temperature. A bound rubber content and Payne effect of the un-vulcanized rubber samples were characterized to study rubber interaction with silica and silica dispersion, respectively. A swelling test was used to determined crosslink density in the rubber samples after a vulcanization system. In addition, the effect of non-rubber components on mechanical properties of rubbers was investigated to find the relationship between the crosslink density and filler-rubber network.

References

[1] S. S. Sarkawi, W. K. Dierkes and J. W. M. Noordermeer, Eur. Polym. J. 49, 10, 3199 (2013).
[2] S. S. Sarkawi, W. K. Dierkes and J. W. M. Noordermeer, Eur. Polym. J. 54, 118 (2014).

Confirmation molecular structure of the *Hevea* rubber molecule and its effects in storage hardening

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Lipids are the one of major non-rubber components discovered in natural rubber (NR) latex, which reported to be the significant parameter affecting the properties of NR.[1,2] Our previous work suggested that associated lipid with the rubber chain end (α-terminal) dominate branching formation in NR [3], which could bring about naturally occurring network and gel formation during long term storage. A number of researches reported that the associated lipid was phospholipid, a kind of polar lipid mainly found in NR.[3,4] However, glycolipid is also the polar lipid mainly discovered in NR [5], the information on the association of glycolipid with the rubber chain end have not yet been investigated. Therefore, the aim of this work was to study the association of lipid to the rubber chain and its effect to the properties of NR during long term storage. In the present work, fresh NR was characterized using nuclear magnetic resonance spectroscopy (NMR) in order to investigate linked lipid with the rubber chain. To further study effect of types of lipid on the storage hardening, deproteinized NR was prepared and subjected to solvent extraction and tranesterification for preparing the rubber samples with different type of residual lipid. The microstructure of NR samples were analyzed using NMR and Fourier-transform infrared spectroscopy (FTIR). Moreover, the NR samples were subjected to study the storage hardening behavior under accelerated condition using phosphorus pentoxide (P_2O_5).

References

[1] S. Amnuaypornsri, S. Kawahara, S Toki, B.S. Hsiao, M Hikosaka, J Sakdapipanich. KGK Kautschuk Gummi Kunststoffe. 65, (2012).
[2] A. Nimpaiboon, M. Sriring, J Sakdapipanich. J Appl Polym Sci. 133, (2016)
[3] L. Tarachiwin, J Sakdapipanich, K Ute, T Kitayama, Y Tanaka. Biomacromolecules. 6, (2005).
[4] L. Tarachiwin, J Sakdapipanich, K Ute,T Kitayama, T Bamba, E-i Fukusaki, *et al.*Biomacromolecules. 6, (2005).
[5] S. Liengprayoon, K. Sriroth, E. Dubreucq, L. Vaysse. Phytochemistry. 72, (2011)

Studies on the effect of purified natural rubber latex and accelerators on rubber allergens in natural rubber dipping product

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Natural rubber (NR) glove is a worldwide use product of NR latex, which is mainly used for protective purposes. However, allergic reactions to NR gloves causing by the residual proteins in NR latex and chemical used in the manufacturing process, which are called as rubber allergens, are still a significant concern [1]. Thus, the present work is an attempt to minimize such the rubber allergens from NR dipping products, herewith, finger cot is used as a model for this study. Purified NR latices were prepared by urea treatment [2] and saponification method [3], called as deproteinized NR (DPNR) and saponified NR (SPNR), respectively. Both of DPNR and SPNR were found to have low nitrogen content. Moreover, Fourier-transform infrared spectroscopy (FTIR) was used to identify functional groups as a result of the absence of the amine functional group, which can be referred to proteins. For a compounded NR, the various purified NR latices and rubber accelerators were used in the compounded formula. The existing and residual proteins of each sample were analyzed by Bradford's assay and sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) method, respectively [4]. The DPNR and SPNR were found to have lower protein profile. The residual rubber accelerators released into artificial sweat were extracted and analyzed by high-performance liquid chromatography (HPLC) technique [5].

References

[1] D.R. Ownby, J Allergy Clin Immunol. 110, (2002).
[2] C. Zhang, M. Yang, K. Zhao, Phys Chem Chem Phys. 19, (2017).
[3] J. Yunyongwattanakorn, Y. Tanaka, J. Sakdapipanich, *et al*., Rubber Chem. Technol. 81, (2008).
[4] P.O. Havanapan, A. Bourchookarn, A.J. Ketterman, C. Krittanai, J Proteomics. 131, (2016).
[5] K.E. Abraham, P. Ramesh, R. Joseph, *et al*., Rubber Chem. Technol. 78, (2005).

Thermal and barrier properties of poly(butylene adipate-co-terephthalate) incorporated with zeolite doped potassium ion for packaging film

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In this research, the works were focused on development of film packaging of poly (butylene adipate-co-terephthalate) (PBAT) incorporated with modified zeolite using (3-aminopropyl) trimethoxysilane. PBAT composites were compounded by melt mixing using twin screw extrusion then molded into film by cast film extrusion process. Effects of zeolite 13X at 1 wt% and zeolite doped potassium ion (K+) on thermal properties, permeability of gases (oxygen, carbon dioxide and water vapor) and also absorption of ethylene gas of PBAT composites films have been studied. Typically, zeolite would act as a nucleating agent. Therefore, adding zeolite would increase the degree of crystallinity of PBAT. Comparing zeolite with and without cation exchange, the degree of crystallinity in film tended to increase for the one doped with potassium ion. Either zeolite with or without potassium exchange had no impact on thermal stability of composite films. Gas permeation of PBAT/zeolite film possessed lower permeation of oxygen and carbon dioxide whereas the water vapor transmission showed relatively higher rate than the neat PBAT. After cation exchange with zeolite, the permeation of oxygen and carbon dioxide has reduced 21.04% and 21.90% respectively but the effect of K+ exchange had no effect on water vapor transmission compared with PBAT. Film of PBAT and zeolite doped with cation could absorb ethylene gas more than the one with zeolite.

Study of rubber composites between natural rubber and Mahogany Shell Powder (MHSP) and potential for pavement block

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This research was aimed to study the feasibility of using mahogany fruit shell power as filler in rubber and investigated in properties of obtained vulcanized rubber. As mahogany fruit shell contains 75.61% holocellulose, 13.54% lignin and 11.02% extractives [1]. Hence the fruit shell should be able to act as reinforcement in rubber materials [2]. In this study, mahogany fruit shell was milled into small particles with the particle size of 58 micrometer. The particle was characterized for their thermal stability. The morphology of mahogany fruit shell powder, MHSP, was flake like particle and can be used as reinforcement fillers in natural rubber. As NR is generally sensitive to O_2 thus ethylene propylene diene monomer, EPDM, would be laminated on the top of NR/MHSP composites. The rubbers were formulated with efficient vulcanization system and contain 10, 20, 30, 40 and 50 phr of mahogany MHSP. The rubber compounds were characterized for cure characteristic parameter such as scorch time, cure time, minimum and maximum torque. Rubber vulcanizates were prepared using compression molding and characterized for their morphology, mechanical properties, thermal degradation, hardness and weathering resistance. In order to improve environment stability and abrasion resistance of the NR/MHSP composites, EPDM/MHSP were prepared and laminated on NR/MHSP and vulcanized. The laminated vulcanizated composites possessed the properties follow Thai Industrial Standard for rubber paving blocks could be obtained. The results also showed that NR filled with 50 phr of MHSP in NR and in EPDM gave the properties follow the standard and has high potential for outdoor rubber paving block.

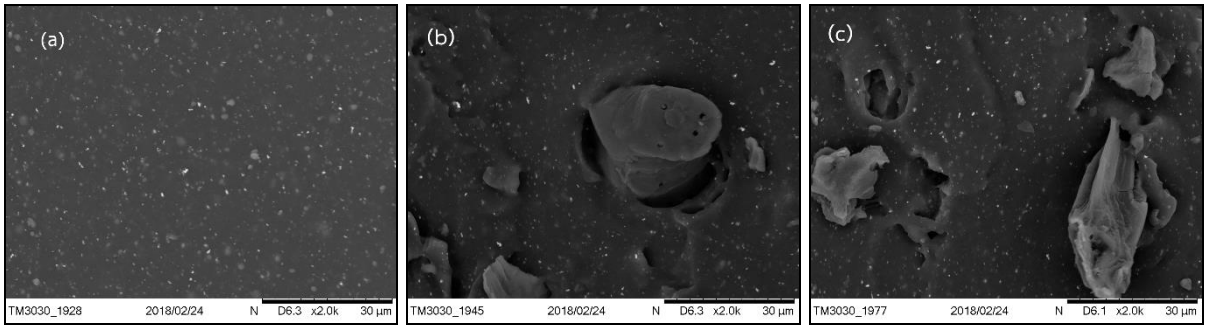

Fig 1. SEM micrograph of NR/MHSP composites (a) 0 phr of MHSP (b) 10 phr of MHSP and (c) 20 phr of MHSP

References.

[1] J. Datta, P. Parcheta and J. Surówka. Softwood-lignin/natural rubber composites containing novel plasticizing agent: Preparation and characterization, Industrial Crops and Products. 95, 675–685. (2017).

[2] L. Bokobzaa and J. P. Chauvin. Reinforcement of natural rubber: use of in situ generated silicas and nanofibres of sepiolite, Polymer Testing. 46, 4144–4151. (2005).

Mechanisms of high grade nitrogen doped graphene synthesis from 5-member ring materials

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In these days, nitrogen doped graphene is expected for many applications such as oxygen reduction reaction catalyst, conductive thin film, and so on, and so various production techniques have been studied. Our study group has been researching for graphene material synthesis by bottom-up process using solution plasma process. Solution plasma process is a new reaction process using in-liquid glow discharge, which enables bottom-up synthesis to synthesize graphene directly from organic materials. There are advantages such as synthesizing hetero-atom-doped graphene from raw materials containing hetero-atom. However, the obtained graphene has the low planarity and crystallinity due to the lone pair of N. In these days, we successfully prepare nitrogen-doped graphene with high planarity and crystallinity from 5-members ring material. The planarity and crystallinity originated from cationic N (N+), which has the same electron configuration with carbon. However, the 6-members ring synthesis from 5-members ring mechanism is unclear. So, it must be revealed for next step study like as increasing synthesis rate, and so on. In this research, we aimed to elucidate the initial formation reactions from 5-members ring molecule, e.g., imidazole. Imidazole was selected as reactant. All the molecular structures were optimized using an ab-inito MO calculation program: the Gaussian 09. To estimate the primary path, the transition state of the reaction was determined by an intrinsic reaction coordinates (IRC) calculation. Moreover, the reaction was discussed from the viewpoint of the variation of standard modes. From the result of the IRC and the vibration calculation, the reaction proceeds with the trend of some steps. The intermolecular C-C bonding rotate 90 degrees and then 5-members ring dimer structure will be transformed to 6-members ring structure. The modes involved in the transition state showed the following changes. At first, the expansion between the imidazole becomes unstable. And next, C-N connection in the imidazole will start to expand. After that, the C-C connection between the imidazole will rotate. It was suggested that the reaction proceeds by starting expansion and contraction because of the balance of π-conjugated state around C-N connection collapses by obtaining a charge of N in imidazole. In this study, it suggested that a compound having an imidazole ring is suitable as a synthesis source of high planarity nitrogen-doped graphene using solution plasma. And this reaction enhanced by cationization of nitrogen.

Effect of Indium on Conductivity and Photosensitivity of Zinc Oxide Nanoflowers

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Zinc oxide is one of the most promising semiconducting materials used in optoelectronics, UV and chemical sensors [1,2]. However, undoped zinc oxide has a relatively low conductivity. In this study, the indium doped zinc oxide nanostructures were successfully synthesized by hydrothermal method. The morphological, structural and optical properties are investigated using scanning electron microscopy (SEM), x-ray diffraction (XRD) and ultraviolet-visible (UV-Vis) spectrophotometer. A low concentration of indium doped zinc oxide nanostructures exhibit hierarchical flowerlike structure, while the zinc oxide nanostructures doped with a high concentration of indium show a partially loss of the flowerlike structure. The x-ray diffraction patterns reveal a highly crystallized hexagonal wurtzite structure. The effects of indium on conductivity and UV photosensitivity of zinc oxide nanoflowers have also been studied. The results show that their electrical conductivity and sensitivity to UV illumination slightly increase depending on the In-to-Zn ratios.

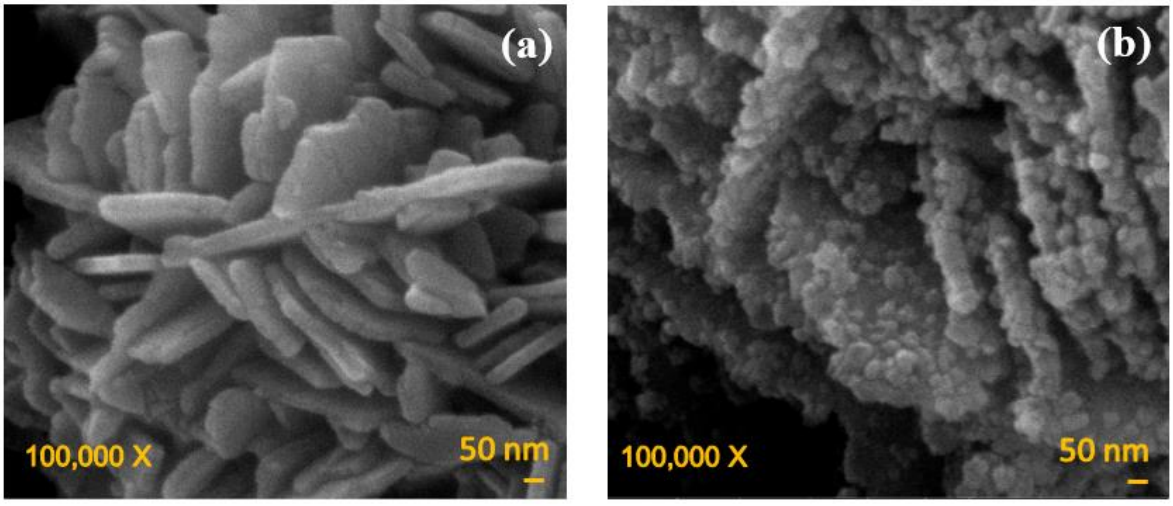

Fig. 1. SEM images of (a) 1% and (b) 5% In:ZnO nanoflowers

References

[1] M. A. Borysiewicz, Crystals. 9(10), 505 (2019).
[2] M. Willander, *et al.*, Superlattices and Microstructures. 43(4), 352 (2008).

A new synthesis route to prepare amphiphilic Pt/C catalyst for highly efficient proton exchange membrane fuel cell

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Proton exchange membrane fuel cell (PEMFCs) is promising alternative power generation technology that converts chemical energy to electrical energy through an electrochemical reaction. Carbon materials have been commonly used as a supporter for platinum (Pt)-based catalyst for the application of a PEMFCs electrodes. However, the pristine carbon with the hydrophobic nature is lack in the benefit owing to its limitation for the mass transportation. Therefore, the further hydrophobic/hydrophilic modification of a carbon-supported is necessary to creating the mass transportation channel. To achieve the goal, in this research, a one-step fabrication of amphiphilic carbon-supported platinum nanoparticle (AmC/Pt) was successfully synthesized through a generation of cold-plasma in the organic solution. This synthesis route eliminates the need hazardous chemicals and multiple steps, as required in the conventional process. Results demonstrated that the PEMFCs efficiency at 0.6 V (0.3 mg Pt·cm^{-2}), a single cell exhibited a maximum current density and power density of 1.41 A/cm^2 and 0.84 W/cm^2, respectively, which was surprisingly ~3.2 times higher than that of commercially available carbon-supported Pt. Furthermore, the AmC/Pt showed the good durability after 5000 cycle tests.

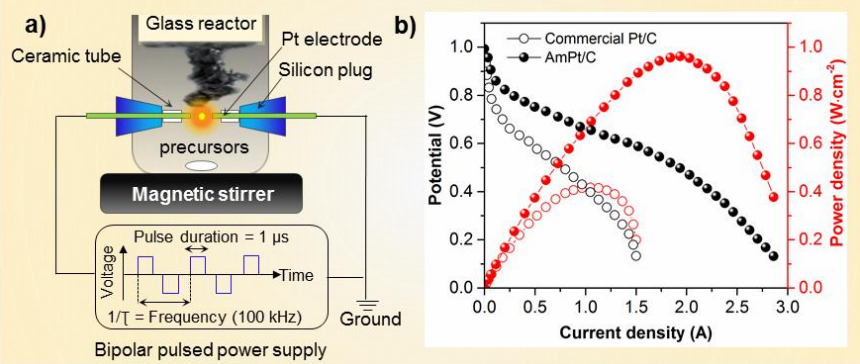

Fig. 1. Schematic illustration of a) the experimental setup for the synthesis of AmC/Pt and b) the FEMFCs performance.

References

[1] M. Weissmann, S. Baranton, J. M. Clacens, C. Coutanceau, Carbon 48, (2010).
[2] N. Saito, M. A. Bratescu, K. Hashimi, Jpn. J. Appl. Phys. 57, 0102A4 (2018).

Hydrothermal Carbonization Synthesis and KOH Activation of Porous Carbons from Waste Marigold Flowers

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Marigold flowers are often discarded as waste at sacred places and temples after religious ceremonies in Thailand. This causes a serious environmental problem for waste management and disposal. Therefore, utilization of waste marigold flowers by converting them into value-added products has recently been received significant attention. In this work, we aim to convert waste marigold flower into porous carbon via hydrothermal carbonization (HTC) synthesis and KOH activation. Waste marigold flower was hydrothermally treated at 180 °C for 24 h, followed by pyrolysis with and without KOH activation at 800 °C under Ar atmosphere. For comparison, waste marigold flowers without HTC were directly pyrolyzed at same condition. From characterization results, all carbon samples exhibited amorphous structure regardless of HTC and KOH activation. By a direct pyrolysis without HTC and KOH activation, carbon sample had low specific surface area of 30 m^2/g due to low surface roughness and lack of porosity. The carbon samples with HTC after pyrolysis showed rough and rupturing surface with a specific surface area of 280 m^2/g, while that after KOH activation revealed a uniform sponge-like structure with a high surface area of 1,825 m^2/g due to significant increase of micro and mesopores. Our results indicate that both HTC and KOH activation are important processes to develop and enhance porosity and specific surface area of carbons.

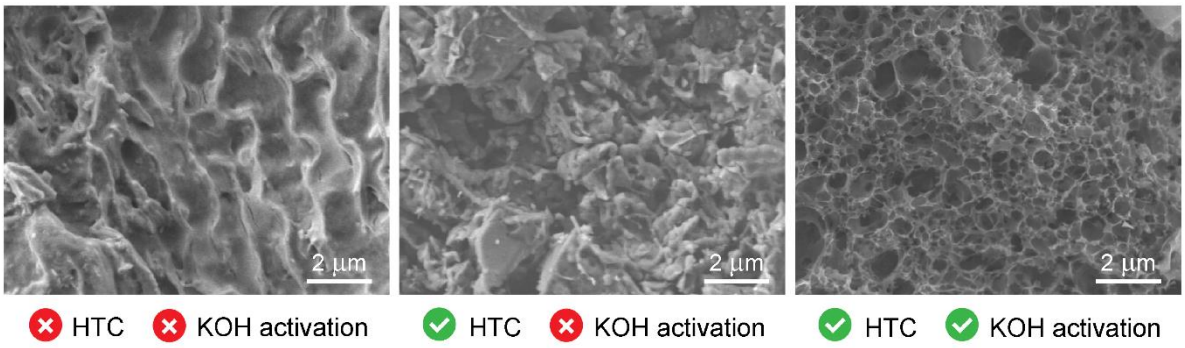

Fig. 1. Scanning electron microscopy (SEM) images of carbon derived from waste marigold prepared by different processes.

Biodegradable poly(butylene adipate-co-terephthalate)/wheat gluten blends: effect of PBAT modification on morphological, mechanical and water adsorption properties

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Poly (butylene adipate-co-terephthalate) (PBAT) is a biodegradable aromatic-aliphatic copolyester with higher flexibility and elongation than PLA and PBS [1] and suitable for various packaging and agricultural applications [2]. However, a major drawback of PBAT is its high cost. In order to overcome the drawback, blending of PBAT with low cost polymers has been an alternative approach. In this work, wheat gluten (WG) was selected to blend with PBAT because of its large availability, low price and biodegradability [3]. Biodegradable polymer blends between poly(butylene adipate-co-terephthalate) (PBAT) and wheat gluten (WG) were prepared in various ratios of 70:30, 60:40 and 50:50 by weight. Modified PBAT with maleic anhydride (PBAT-g-MA) used as a compatibilizer in this work. Morphological, mechanical and impact properties and also water adsorption of the PBAT/WG blends with and without the compatibilizer were investigated. Scanning electron microscopic (SEM) analysis revealed that the PBAT/WG blends with PBAT-g-MA showed a better compatibility between PBAT and WG phases. Moreover, addition of the compatibilizer into the blends significantly improved tensile strength, elongation at break and impact strength compared to the PBAT/WG blends without compatibilizer. However, water adsorption of the blends with compatibilizer is higher than that of uncompatibilized PBAT/WG blends.

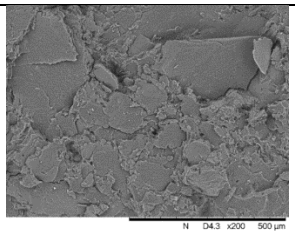
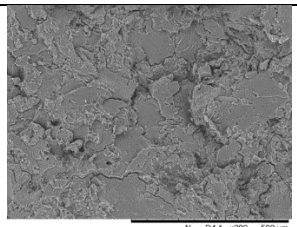
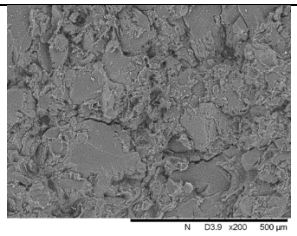
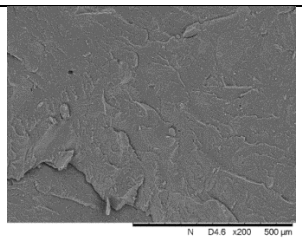
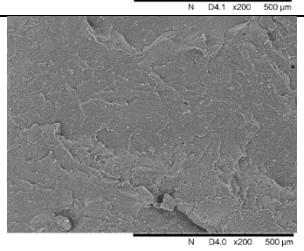
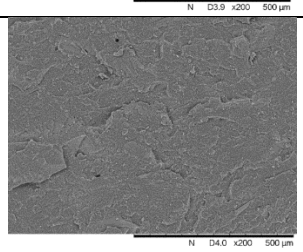
PBAT/WG	70:30	60:40	50:50
No added compatibilizer			
Added compatibilizer			

Fig. 1. SEM images of the PBAT/WG with and without the compatibilizer

References

[1] S.S. Ray, M. Okamoto, Macromolecules, 36, 2355 (2003)
[2] L. Averous, J. Macromol. Sci. Part C Polym. Rev. 4, 231 (2004)
[3] N. Gontard, S. Guilbert, J. Cuq, J. Food Sci. 57,190 (1992)

Electrical and mechanical properties of PEDOT:PSS strain sensor based microwave plasma modified prevulcanized rubber surface

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The poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PEDOT:PSS) conductive polymer has been extensively used in various application including flexible electrode and stretchable sensor[2],[3]. This study reports the electrical and mechanical strain behaviors of PEDOT:PSS deposited on prevulcanized rubber substrate. Which is modified surface by microwave plasma. The effect of plasma treatment cycles on adhesion of PEDOT:PSS coated prevulcanized rubber and conductivity have been investigated. The results show a uniform PEDOT:PSS film on rubber surface after treating with microwave plasma. The electrical conductivity slightly increase by increasing treatment cycles. In addition, an electrical strain and mechanical strain increase up to 29.06 and 19.5%, respectively under 4 treatment cycle.

References

[1] X. Fan, N. Wang, F. Yan, J. Wang, W. Song and Z. Ge, A Transfer-Printed, Strechable, and Reliable Strain Sensor Using PEDOT:PSS/Ag NW Hybrid Films Embedded into Elastomers, Adv. Mater. Technol., vol. 3, 1800030 (2018).
[2] X.Fan, B. Xu, S. Liu, C. Cui, J. Wang and F. Yan, Transfer-Printed PEDOT:PSS Electrodes Using Mild Acids for High Conductivity and Improved Stability with Application to Flexible Organic Solar Cells, ACS Appl. Mater. Interfaces, 14029-14036 (2016)
[3] H. Wu, Q. Liu, W. Du, C. Li and G. Shi, Transparent Polymeric Strain Sensors for Monitoring Vital Signs and Beyond, ACS Appl. Mater. Interfaces, vol. 10, 3895-3901 (2018)

Effect of isopropyl alcohol on silver nanowire networks for transparent thin film heater

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Silver nanowires (AgNWs) are one of most interested materials used as transparent electrodes in electronic devices including heater [1], organic light emitting diode [2], solar cell [3] and strain sensor [4]. This work study electrical conductivity and distribution of silver nanowires (AgNWs) film on glass substrate. The AgNWs thin film are prepared by spin-coating a dispersed solution of AgNWs in different IPA to water ratios. The results show that lower IPA ratio increase adhesion of AgNWs on glass substrate. The AgNWs thin film exhibits a low electrical resistance of ~10 Ω when IPA mixing ratio less 0.5. The high conductivity of AgNWs thin films can be attributed to their uniformly interconnected AgNWs networks. Under optimized condition, a transparent AgNWs thin film is fabricated as heating element, which yields an effective heat generating at input low voltages.

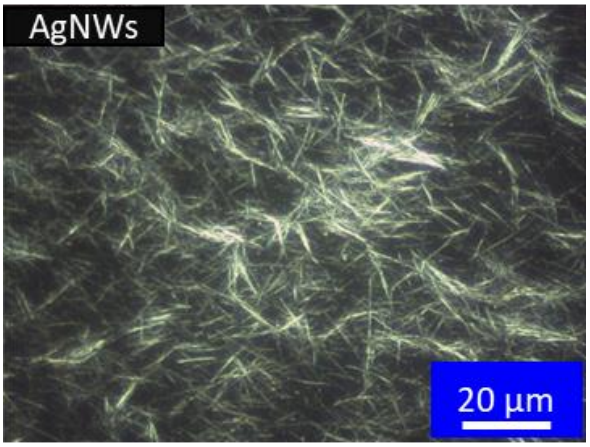

Fig. 1. The optical image of AgNWs networks

References

[1] Y. Cai, et al., Mater. Lett. 249, (2019).
[2] L. Li, et al., Adv. Mater. 23, 46 (2011).
[3] D.-S. Leem, et al., Adv. Mater. 23, 38 (2011).
[4] M. Mohammed Ali et al., Sens. Actuators, A. 274, (2018).

Influence of Ethylene Glycol Treatment on Conductivity and Stability of PEDOT:PSS Coated Cotton Yarn

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Recently electronic textiles have received much interest due to their board applications in wearable electronics such as solar energy, physical and chemical sensors[1, 2]. In this work, the conductive cotton is prepared by dip coating poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) on commercial cotton yarn. The electrical conductivity of conductive cotton can be enhanced by secondary treated PEDOT:PSS with ethylene glycol (EG). The EG-treated conductive cotton exhibits lower resistance of 600 Ω/cm by comparison with the pristine PEDOT:PSS coated cotton yarn(110 kΩ/cm). The electrical resistance of the conductive cottons are also investigated as a function of temperature and washing cycles. The pristine conductive cotton increases in electrical resistance as the temperature increases, while there is no resistance change for EG-treated conductive cotton. SEM images show well distribute of PEDOT:PSS on the cotton yarn surface. FTIR analysis also confirms the residue of PEDOT:PSS coated on cotton yarn. In addition, the treated conductive cottons exhibit high stability under air as they show slightly change in electrical resistance after keeping for 10 days and after 6 washing cycles.

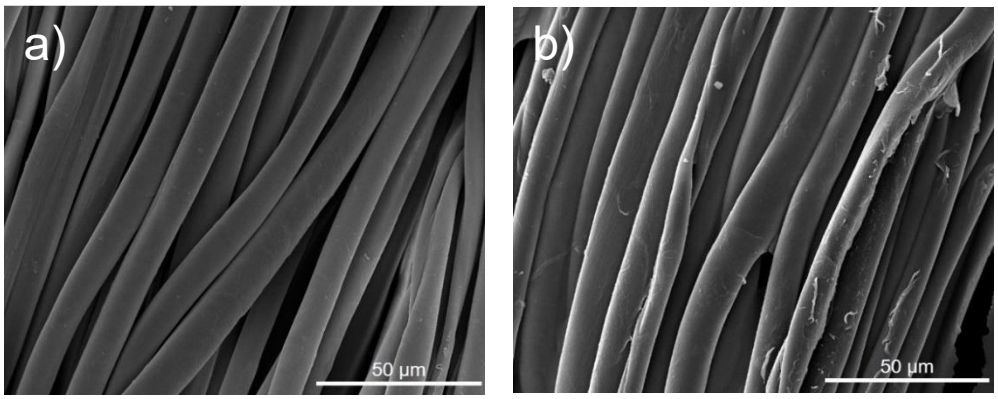

Fig. 1. SEM images of a) bare and b) PEDOT:PSS coated cotton yarns.

References

[1] S. Wu, P. Liu, Y. Zhang, H. Zhang, and X. Qin, Sens. Actuators,B. 252,697-705 (2017).
[2] N. Indarit, Y.-H. Kim, N. Petchsang, and R. Jaisutti, RSC Adv. 9,26773-26779 (2019).

Method Development for Determination of Brominated Flame Retardants in High-impact Polystyrene using X-ray Fluorescence Spectrometry

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An accurate qualitative of bromine has been influencing on flame retardant properties of polymeric materials. Analytical techniques for determining bromine can be performed by ion-chromatography, inductively coupled plasma optical emission spectrometer etc. However, most of the methods require complicated sample preparation and time consuming. A wavelength dispersive x-ray fluorescence (WDXRF) method can solve that problem but requires suitable standards or reference materials (RM). The purpose of this study was to develop a feasible method for the determination of bromine content in high-impact polystyrene (HIPS) using WDXRF. The calibration of primary RM and secondary RM (brominated flame retardant additive) were prepared using internal mixer ranging from 1 to 13 wt% of bromine in HIPS followed by cryogenic-grinding and hot press as solid disks. WDXRF calibration curves of bromine shown a good linearity ($r^2 > 0.999$). It was validated with an internal-standard composing 10 wt% of bromine. The method was applied to 10 HIPS samples. The calibrating disk had a homogenous bromine distribution. Stability test have been evaluated. No significant decrease of bromine content in these standard disks occurred. This method was suitable and reliable for fast and accurate quantification of brominated flame retardants in HIPS materials without tedious sample preparation.

References

[1] Miskolczi, N.; Hall, W.J.; Borsodi, N.; Williams, P.T.; Angyal, Microchem J. Rev. Lett. 99, 60-66 (2011).
[2] Izgi, B.; Kayar, M, Talanta. Rev. Lett. 139, 112-122 (2015).

Performance of lightweight cement board using coconut coir fiber and expanded polystyrene foam waste

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Nowadays, the rapid growth of urbanization and industrialization has generated huge amounts of industrial and agricultural wastes [1,2]. A circular economy in recycling and waste management is a systematic approach to minimize the problem. In this work, lightweight cement hybrid materials based on expanded polystyrene (EPS) foam waste and coconut coir fiber have been developed as an effective method for industrial and agricultural wastes management. The purpose of this study is to investigate the effects of EPS foam and coconut coir fiber as cement replacements at various proportions of EPS foam and coconut coir fiber and different lengths of coconut coir fiber on the properties of fiber cement board. Fiber cement boards containing partial replacement of cement by 1, 2 and 3% coconut coir fiber with three different fiber lengths (1, 2 and 3 cm.) and 1, 2, 3 and 4% EPS foam were prepared. The physical and mechanical properties of the specimens were determined after 28 days of hydration. The results revealed that EPS foam and coconut coir fiber can be used as replacements for cement in the production of fiber board cement to obtain inexpensive, lightweight and strong product. The flexural strength and impact strength of the composites increased with the increase in coconut coir fiber. Meanwhile, the density decreased along with the addition of coconut coir fiber and EPS foam.

References

[1] A.C. Abdullah, C.C. Lee, Procedia Engineering, 180, 1266-1273 (2017).
[2] M.A.R. Bhutta, Y. Ohama, K. Tsuruta, Constr. Build. Mater. 25, 779-784 (2011).

Efficient removal of methylene blue by low-cost and biodegradable highly effective adsorbents based on biomass in the fixed bed column

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Several industries, such as textiles, printing inks, paints, paper pulp, and dyeing plants result in a large amount of coloured effluent [1]. Dye production can generate a lot of wastewater, and dye loss in the process of dyeing and printing, half of which is discharged into the environment [2]. Remediation of aquatic environments polluted by dye has attracted much attention of many environmental engineers and researchers. In this study, spent coffee, water hyacinth and biochar derived from water hyacinth were used as low-cost waste material for the removal of methylene blue in dye solution. Isothermal biosorption experiments were performed using a column at various concentrations and bed heights. Experiments were conducted to investigate the effects of various parameters on the breakthrough and saturation time. Both the breakthrough and saturation time increased with the increment of the bed height. Due to differences in adsorption capacity, the trend line changed from a straight line to an arc at C_t/C_0 = 0 – 0.1, when the breakthrough time was raised. The best adsorption capacity was shown by the related breakthrough time. Column data obtained at different conditions were described using Yoon–Nelson, Thomas and Modified Dose–Response models. The Yoon–Nelson model was selected to predict the 50% breakthrough time acquired by the column system and gave the estimated breakthrough time for the column that was not exhausted during the operation. The Thomas and Modified Dose–Response models revealed that the maximum adsorption capacity (q_0) was enhanced with the increment in the bed height.

References

[1] J. Anandkumar and B. Mandal, J. Hazard. Mater., 186(2–3), 1088–1096 (2011).
[2] E. Y. Ozmen, S. Erdemir, M. Yilmaz and M. Bahadir, Clean: Soil, Air, Water, 35(6), 612–616 (2007).

Enhanced mechanical performance of cement board composite reinforced with coconut coir fiber and tire rubber waste

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Composite materials with both economic and environmental benefits are being considered for applications in the building and construction industries. After banning asbestos fibers because of its hazardous impacts on human health, developing low-cost, strong, and durable cement board remains one of the greatest challenges [1]. In present, there are many waste materials for cement board production to achieve desired properties or to reduce the cost of the final products [2]. This investigation focused on the coconut coir fiber length, amount of coconut coir fiber and tire rubber waste that affected the properties of cement boards. In the sample preparation, cement boards were prepared by partial replacement of cement by tire rubber waste with different percentages (2.5, 5.0, 7.5 and 10 %) and coconut coir fiber with different percentages (1, 2, 3 and 4%) using fiber length of 0.5, 1, 2 and 3 cm. After 28 days of hydration, the mechanical and physical properties of the cement boards were evaluated. Here we observed that, both the flexural strength and impact strength of the cement boards increased with an increase in the content of tire rubber waste and coconut coir fiber. Moreover, the results also showed that as the fiber content was increased, the increase in water absorption occurred, whereas the density decreased with the increase in tire rubber waste and coconut coir fiber. Therefore, tire rubber waste and coconut coir fibers can be utilized as a good replacement of cement for cheap, lightweight and eco-friendly reinforced cement boards.

References

[1] S.H. Park, Safety and Health at Work. 9, 360-364 (2018).
[2] C. Asasutjarit, et al., Constr. Build. Mater. 21, 277–288 (2007).

One-pot synthesis of cationic nitrogen-doped graphene

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Tailoring electrical properties of graphene by nitrogen doping is currently of great significance in a broad area of advanced applications. Bonding configuration of nitrogen atoms in graphene plays the vital role in controlling its electrical, chemical and optical properties. Here, we report for the first time a simple bottom-up synthesis of a novel cationic nitrogen-doped graphene (CNG) by a solution plasma (SP) (Fig. 1). A mixture of ionic liquid and organic solvent was used as starting precursor. CNG exhibited an orthorhombic structure possibly due to the presence cationic nitrogen in hexagonal graphene lattice. Nitrogen doping content was found as high as 13.4%. Electrical characterization demonstrated that the CNG exhibited a unique p-type semiconducting behavior with superior electrical conductivity and carrier concentration. Such unique electrical characteristics of CNG are mainly attributed to the presence of cationic nitrogen with preserved planar structure.

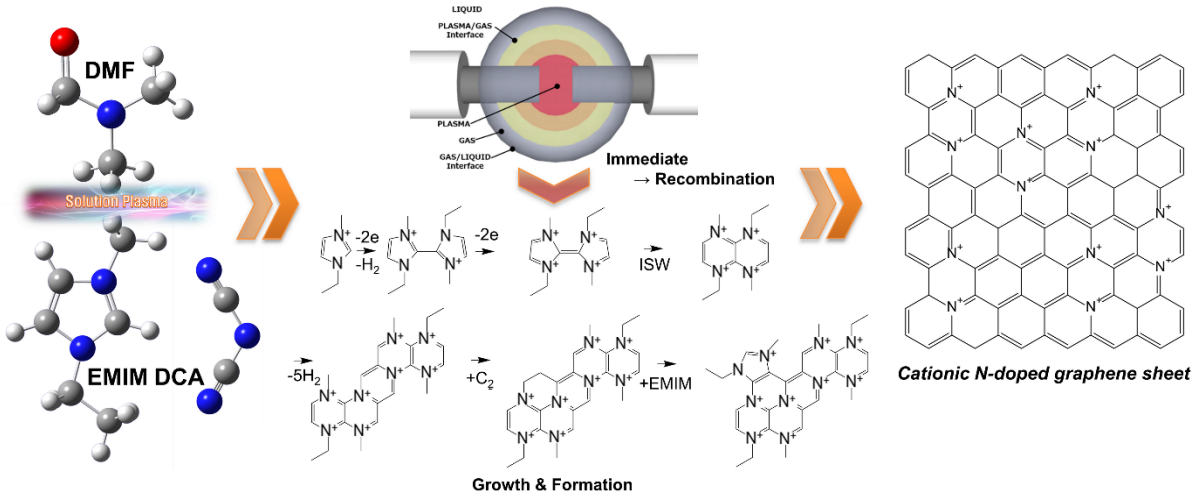

Fig. 1. Schematic illustration showing the synthesis of CNG from the mixture of EMIM DCA and DMF by SP.

References

[1] P. Avouris, uthorb, C Authorc, Nano Lett. 10, 4285-4294 (2010).
[1] D. Chen, *et al.*, Chem. Soc. Rev. 39, 3157-3180 (2010).

Synthesis and mechanical properties of NR/EPDM for floor mat

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Fall-related injuries are a major health problem for elderly adult. This research aims to develop soft rubber floor mat for prevent fall-related injuries in elderly adult. The hardness of these rubber floor mats are 40 Shore A and 50 - 60 shore A, respectively. Therefore, the standard of hardness in this work for natural rubber floor mats is in between 40-45 Shore A by using the natural rubber STR5L mixed with the synthetic EPDM rubber for 4 ratios: 100:0, 90:10, 80:20 and 70:30, respectively. The results showed that the synthetic EPDM rubber can help to protect ozone. When the synthetic EPDM rubber was increased the tensile strength and resistance to stretching decreased. The modulus at 100% strain and impact strength of compound rubbers was increased with the increasing of the synthetic EPDM rubber. The tensile strength and elongation at break of compound rubber were decreased with the increasing of the synthetic EPDM rubber. When taking the compound rubbers to do the deterioration under incubation at 70^{o}C during 72 hrs; the result showed that hardness, tensile strength and modulus at 100% strain values were increased. The value of shock absorption is 37% which can help to release shock. Therefore, the compound rubber in the ratio of 70:30 is the potential to develop the natural rubber floor mat for the elder adult.

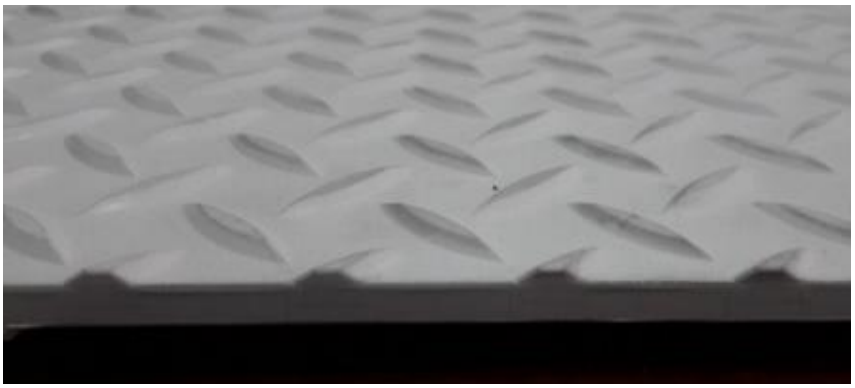

Fig. 1. The example of floor mat rubber.

References

[1]. Arayapranee W., Rempel G.L. (2007). Properties of NR/EPDM Blends with or without Methyl Methacrylate-Butadiene-Styrene (MBS) as a Compatibilizer. International Journal of Materials & Structural Reliability. 5(1):1-12.

[2]. Glasse M.D., Idris R., R.J. Latham, R.G. Linford, W.S. Schlindwein. 2002. Polymer electrolytes based on modified natural rubber. Solid State Ionics. 147: 289– 294.

[3]. Choi, S.S. 2001 Influence of internal strain on change of crosslink density of natural rubber vulcanizates by thermal ageing. Polyrn. Int. 50: 107-112.

Synthesis of carbon dots from the biomass product for supercapacitor applications

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Biomass-derived CDs were prepared via a green one-step synthetic technique using orange juice as CD precursor. The as-prepared CDs were used to fabricate composites with rGO via a one-step hydrothermal method as present in Fig. 1. The rGO/CD composites were thoroughly analyzed through physical and electrochemical characterizations. The capacitive properties of electrodes in 2 M KOH aqueous electrolyte were systematically studied by cyclic voltammetry, galvanostatic charge-discharge measurements, and electrochemical impedance spectroscopy. The electrochemical performance of the electrodes was investigated with the variation of GO to CD mass ratios. The rGO/CD composite with a 4: 1 mass ratio exhibits high specific capacitance with maximum capacitance of 184.8 F g^{-1} at a current density of 0.5 A g^{-1}.

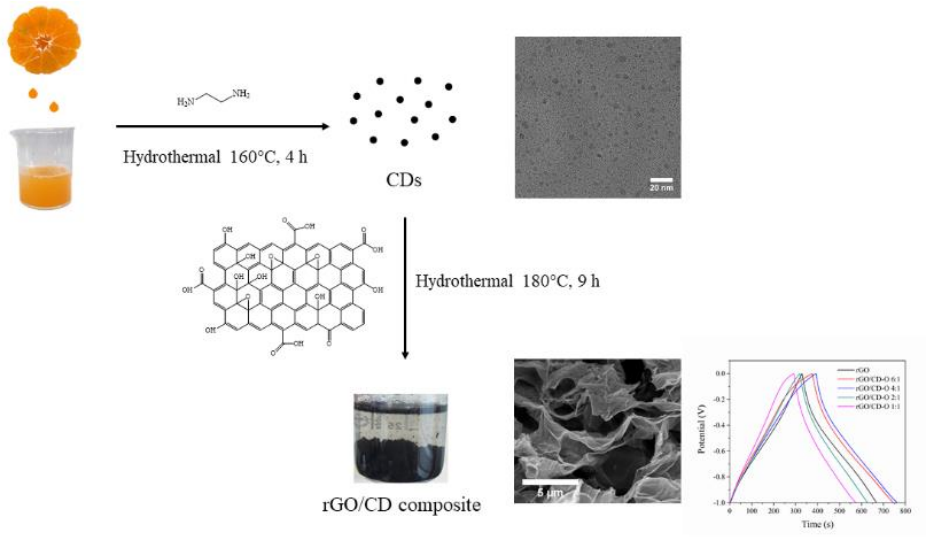

Fig. 1. Synthesis route of rGO/CD composite.

References

[1] V.C. Hoang, L.H. Nguyen, V.G. Gomes, J. Electroanal. Chem. 832, 87 (2019).
[2] A. Tibodee, *et al.*, Mater. Chem. Phys. 235, 121755 (2019).

Design and Develop Rubber Sculpting for Stop Motion Animation

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The purposes of this research were to study the process of create and use rubber materials for designing, molding, coloring, and creating characters' textures to have properties suitable for stop-motion animation. From the experiment and testing by the research team, the results showed that rubber properties were soft, flexible, and stable at a good level. Compared with stop-motion characters created from silicone, it had similar properties. However, there was an outstanding quality in coloring because it is a water-based color, be able to make colors from the experimental color formula that can be mixed up according to the designed work, and had a quality to create gestures and motion for stop-motion animation appropriately.

A 3DRISM study of water and potassium ion adsorption in Montmorillonite nanoclay

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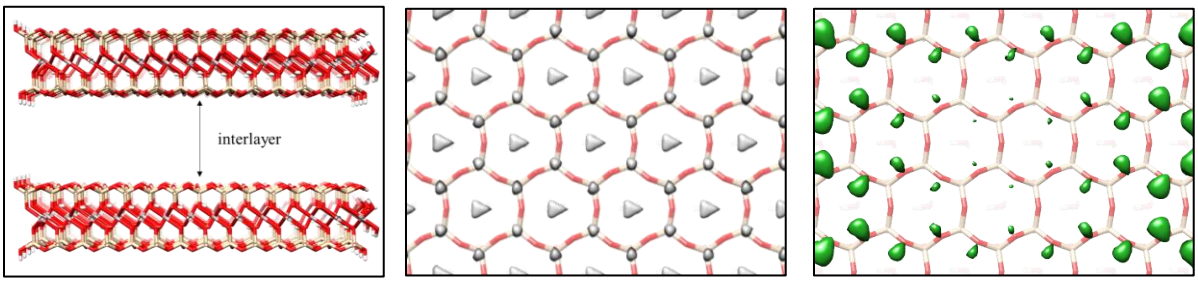
Montmorillonite (MMT) is one of the most important clay minerals in various industrial applications. In this study, a three-dimensional reference interaction site-model (3DRISM) theory [1] and CLAYFF force field [2] has been used for investigating the water and K^+ distribution in bi-layers MMT [3] (fig. 1a). The results from 3DRISM show that the water bound to the surfaces with different sites of MMT as shown in figure 1b. From the 3D-DF of K^+ (fig. 1c), we found the K^+ distributed inside and form a complex structure with one bridge oxygen on surfaces of MMT. Moreover, we also analyzed the coordination environment of K^+ and water in the interlayer of MMT and the results show agreement with experiments and other simulation studies [4, 5].



(a) (b) (c)

Figure 1. (a) A structure of bi-layers MMT. (b) 3D-DF of oxygen of water and (c) K^+ at g(r) = 5 on the inner-surfaces of MMT, respectively.

References

[1] N. Yoshida et al., *J. Phys. Chem. B.*, **2009**, 113, 873-886.

[2] R.T. Cygan et al., *J. Phys. Chem. B.*, **2004**, 108, 1255-1266.

[3] M. Gutierrez and H.R. Fuentes, *Appl. Clay Sci.*, **1996**, 11, 11-24.

[4] M. Fu et al., *Clays Clay Miner.*, **1990**, 38, 485-492.

[5] L. Sun et al., *Chem. Phys.*, **2015**, 455, 23-31.

SERIES SEMINARS

Small angle x-ray scattering: fundamental concepts and applications in probing the nanostructure of biomolecular self-assemblies

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In this seminar I will give first a quick introduction to SAXS and then provide an overview of our research efforts on studying the hierarchically organized structures of charged biopolymers and protein networks. I will focus on two particular groups: nucleic acid (DNA and RNA)-lipid complexes and nanotubes constructed with cytoskeletal proteins (microtubules). SAXS played a critical role in determining the structure of these complexes which span the length scale range of a few nm to 10's of nm. Real space imaging, in particular high resolution TEM, provided much needed complementary information enabling quantitative modeling of SAXS data. These studies are motivated by understanding the fundamental physical forces that drive the self-assembly, which may lead to 'smarter' design of biomolecular materials with practical applications.

Biomaterials, their structure, function and applications

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Evolution of species is naturally linked to the evolution of molecules, during which the nature has mastered perfection for both. As biologists analyze the living world other scientists take advantage of the molecular interactions and often apply them into new useful materials. Consequently, biomaterials can be viewed as macroscopically formed objects where the structure of biomolecules is defined. Among those molecules, of which scientists have borrowed from nature are most often proteins, nucleic acids, sugars, lipids or any mixture of those. During this lecture we will discuss the application of different species for the creation of soft matter that are biomaterials. For instance, in recent 20 years DNA and RNA have been developed as a media for designing responsive biomaterials. Their programmability by the sequence, biocompatibility by nature, predictable folding and specific recognition potential have been used for the formation of structural bionanoscaffolds. The diversity of natural and artificially created peptides and proteins have also been successfully applied for functional biomaterials. More recently the specific methodology (3D printing for instance) defined the new way of formation of soft materials to be used in natural environment including the human body. Polymers used for such application may be artificial, but as these will operate in bio-environment must be biocompatible and as such we must understand and control its influence. As these materials can be viewed from the perspective of macroscopic world, but also is defined by the precise interactions between molecules, the specific set of methods is used to create (synthetize) and analyze them. Most common are: optical imaging analysis, SEM, TEM, CryoEM, X-ray methods (SAXS, WAXS), AFM, FTIR, but also biocompatibility and stability by enzymatic degradation, cytotoxicity etc. We will also briefly review these methods, their advantages and limitations.

Design of gold hierarchically ordered crystals architectures for electrochemical detection of traces of molecules

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Nowadays, noble metallic nanostructures with unique morphology are widely used as new sensors due to their fascinating properties. Among various shapes, dendritic nanostructures have attracted much attention because of their large surface-to-volume ratio, high sensitivity and special texture with sharp tips and nanoscale junctions. Several methods have been developed to fabricate those specific structures such as electrodeposition, seed-mediated growth or wet chemical method [1]. Among all these processes, the chemical route is mainly used due to its simplicity and low cost. However, this technique requires to create proper conditions by adjusting reaction conditions [2] such as solvent, reactant concentration, additives, temperature and pH. Indeed, the nanostructures growth process, their size, shape and distribution depend on all these key parameters. The present study deals with a novel approach for a controlled growth pattern-directed organisation of Au flower-like crystals (NFs) deposited onto stainless steel plates to achieve large-scale functional surfaces. The spectroscopic and the electrochemical activity of the hierarchically structured surfaces have been investigated as a function of the size, morphology and distribution of the hierarchical metallic crystals. The method consists in the deposition of a soft nanoporous template [3], on which Au NFs are grown by seed-mediated method. After the preparation of the pre-patterned surfaces, the second step corresponds to the growth of metallic nanostructures inside the pores of the masks. The size and morphology of the Au NFs are controlled by a site-selective heterogeneous nucleation and growth process. The growth mechanism of the template-directed synthesis of Au crystals arrays has been investigated as function of the different physico-chemical parameters. The optical and electrochemical properties of Au NFs arrays were studied as a function of their morphology and organization [3]. Dendritic Au nanostructures have appeared as excellent Raman-active candidates due to the presence of very sharp tips of multi-branched Au nanoparticles that leads to a large local field enhancement and a good SERS sensitivity. In addition, these structures have also been used as electrochemical sensors to detect traces of organic molecules present in a solution. A correlation of the number of active sites on the surface and the current charge by both colorimetric method and cyclic voltammetry of gold structures have allowed a calibration of the system. Results show that this sensing platform is able to detect traces of molecules below ppb concentration. This device represents a first step for the fabrication of MEMs device that could ultimately be integrated in a lab-on-chip system. This facile and simple multistep approach is particularly attractive due to its environmentally gentle processing conditions and represents an open pathway to several technologically large-scale nanomaterials fabrication such as hierarchically ordered crystal architectures for sensor applications.

[1] L. Zhao, X. Ji, X. Sun, J. Li, W. Yang, X. Peng, Journal of Physical Chemistry C (2009), 113, 16645.
[2] L. Chen, L. Wang, Z. Zeng, T. Xu, Surface and Coatings Technology (2006), 201, 599.
[3] P. Bauer, K. Mougin, V. Vignal, H. Krawiec, M. Rajab, A. Buch, P. Ponthiaux, D. Faye, Annales de Chimie Science des Matériaux (2016), 40, 43. [8] Yupensuk W and Ongkunaruk P 2016 The Improvement of a Thai Organic Rice Supply Chain: A case Study of a Community Enterprise *International Conference on Agro-Industry 2015* KnE Life Sciences 156-160.

Working with nature: Designing a structural biocomposite

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Most natural materials are multifunctional composites with complex hierarchical structures, typically built from simple, yet efficient constituent nanoscale biopolymers and biominerals. This talk will first begin by exploring some of the lessons we have learnt through function-structure-property-processing relations in some of nature's marvellous materials and structures, including: the non-woven silk cocoons of Bombyx Mori silkworms, the highly-oriented filamentous nanocomposite tubes of the Chaetopterus sp. marine worm, the bird-catching silken orb webs of Nephila edulis, the polylaminate structure of plant cell walls, and the dentinous ivory of elephants. While we have used biomaterials like wood, hemp and silk for diverse applications since pre-historic times, their potential has not been fully-exploited yet. Natural materials are of increasing interest to today's material world not only for direct usage (to alleviate some of the environmental issues associated with using man-made materials), but also for bioinspiration (to make novel and more efficient man-made materials). This talk further explore some of our team's research on biomaterials such as wood, hemp and silk and how they can be employed in a variety of structural applications, from building components to turbine blades and from automotive parts to consumer products.

NOTE