

Thermoresponsive Polymer Brushes Prepared by Post-Polymerization Modification of Poly(pentafluorophenyl acrylate) for Tissue Engineering Applications

Metawee Bunwanna¹, Supaporn Khranchantuk², Nipan Israsena² and Voravee P. Hoven^{3*}

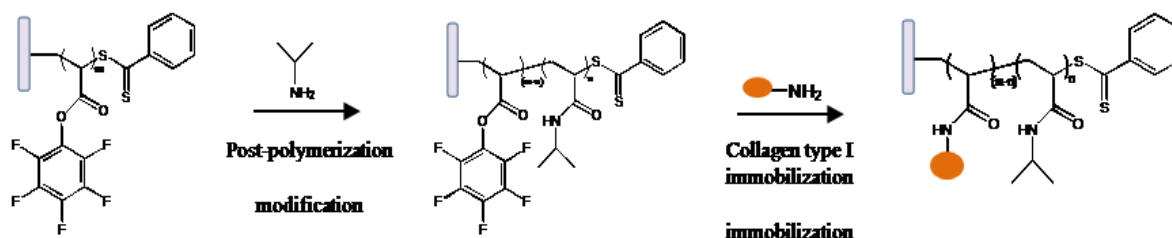
¹Program in Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

²Stem Cells and Cell Therapy Research Unit, Department of Pharmacology, Faculty of Medicine, Chulalongkorn University, Ratchadumri Road, Pathumwan, Bangkok 10330, Thailand

³Organic synthesis Research Unit, Department of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

*E-mail: vipavee.p@chula.ac.th

Poly(pentafluorophenyl acrylate) (PPFPA) is an attractive precursor polymer having active ester groups which can rapidly react with amines under mild conditions via post-polymerization modification. Here in this research, polymer brushes of PPFPA were fabricated on glass substrates by either “grafting from” or “grafting to” methods via reversible addition–fragmentation chain transfer (RAFT) polymerization. Post-polymerization modification of PPFPA brushes was performed by a reaction between the surface-grafted PPFPA brushes and isopropylamine (IPA) to obtain copolymer brushes of PPFPA and thermoresponsive poly(*N*-isopropylacrylamide) (PNIPAM). ¹H NMR, FTIR, and water contact angle measurements proved the successful partial conversion of PPFPA to PNIPAM, yielding PPFPA-*co*-PNIPAM brushes, of which composition can be controlled by IPA concentration and reaction time. Tandem modification of the remaining PPFPA units in the copolymer with Collagen type I, a cell adhesion promoter was found to enhance adhesion of Keratinocyte cell upon cell culturing. Preliminary investigation has suggested that this multifunctional and thermoresponsive platform can be used for cell sheet fabrication which is beneficial for tissue engineering applications.



Keywords Poly(pentafluorophenyl acrylate); Post-polymerization modification; Active ester polymer; Cell sheet

Synthesis and Spectroscopic Study of Polyfluorene and its Copolymer

Witsanu Sombat¹, Benjawan Somchob¹, Natsiri Wongsang¹ and Rukkiat Jitchati^{1*}

¹*Center for Organic Electronic and Alternative Energy (COEA), Department of Chemistry, Faculty of Science, Ubon Ratchathani University, Warinchamrap, Ubon Ratchathani Province, 34190, Thailand*

**E-mail: rukkiat_j@hotmail.com*

In this work, we synthesized and characterized poly(9,9-di-n-dihexylfluorene (WN-P01), poly[(9,9-di-n-dihexylfluorene)-co-(1,4-phenyl)] (WN-P02 and WN-P03) and poly[(9,9-di-n-dihexylfluorene)-co-(9,10-anthracenyl)] (WN-P04 and WN-P05) by using Suzuki-Miyaura polymerization reaction. The photophysics of all polymers were studied by UV-Vis absorption and emission spectroscopy. We found that the similar absorption from $\pi-\pi^*$ transition of the polymer backbone chains was observed. Furthermore, the polymers showed the emission in the blue region (417-440 nm). We also found that the maximum absorption wavelength of the polymer was dependent on the solvent type. All the synthesized polymers will be used as polymer light-emitting diodes (PLEDs) in the future.

Keywords Copolymerfluorene; Polyfluorene; PLED

Effects of Blend Ratio and Block Length on Crystallinity and Mechanical Properties of Biodegradable Stereocomplex Poly(lactide)-*b*-Poly(propylene Glycol)-*b*-Poly(lactide)

Dutchanee Pholharn^{1*} and Yodthong Baimark¹

¹*Biodegradable Polymers Research Unit, Department of Chemistry, Faculty of Science, Mahasarakham University, Mahasarakham, 44150, Thailand*

*E-mail: dutchanee_doso@hotmail.com

Stereocomplex poly(lactides) are poly(L-lactide) (PLL)/poly(D-lactide) (PDL) blends that have improved thermal ($T_m = \text{ca. } 230^\circ\text{C}$) and mechanical properties when compared to the original PLL and PDL ($T_m = \text{ca. } 170^\circ\text{C}$). In this work, novel biodegradable stereocomplex of PLL-*b*-poly(propylene glycol)-*b*-PLL (PLL-*b*-PPG-*b*-PLL) and PDL-*b*-poly(propylene glycol)-*b*-PDL (PDL-*b*-PPG-*b*-PDL) triblock copolymer blend films were prepared by a solvent casting method. The influences of PLL-*b*-PPG-*b*-PLL/PDL-*b*-PPG-*b*-PDL blend ratios (75/25, 50/50, and 25/75 w/w) and poly(lactide) block lengths (20,000 and 40,000 g/mol) on stereocomplexation were investigated. The PLL-*b*-PPG-*b*-PLL and PDL-*b*-PPG-*b*-PDL were synthesized by ring-opening polymerization of L-lactide and D-lactide monomers, respectively, in bulk using stannous octoate and PPG as the initiating system. Crystallinity of the blend films was studied by differential scanning calorimetry (DSC). Poly(lactide) block lengths in range of this study did not affect stereocomplex crystallinity. The stereocomplexation was completely formed at the blend ratio of 50/50 w/w. The stereocomplex blend films exhibited higher tensile strength and elongation at break than those of the original PLL-*b*-PPG-*b*-PLL and PDL-*b*-PPG-*b*-PDL films. The 50/50 blend films showed the highest tensile strength and elongation at break. The higher poly(lactide) block length improved mechanical properties of the blend films. These results suggest that the mechanical properties of the stereocomplex triblock copolymer blend films strongly depended upon the blend ratio and poly(lactide) block length.

Keywords Bioplastics; Block copolymers; Stereocomplex poly(lactides); Crystallinity; Mechanical properties

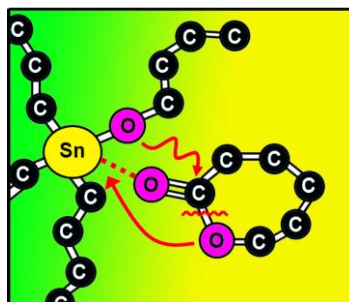
Kinetic Study of The Ring Opening Polymerization of ϵ -Caprolactone Initiated by Tri-*n*-butyltin *n*-Butoxide Using Proton Nuclear Magnetic Resonance Spectroscopy

Wanich Limwanich¹, Sureerat Khunmanee¹, Puttinan Meepowpan¹,
Nawee Kungwan¹ and Winita Punyodom^{1*}

¹*Biomedical Polymer Technology Unit, Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand*

**E-mail: winitacmu@gmail.com*

The kinetics of bulk ring-opening polymerization (ROP) of ϵ -caprolactone (ϵ -CL) initiated by the synthesized tri-*n*-butyltin *n*-butoxide ($n\text{Bu}_3\text{SnOnBu}$) was investigated by proton nuclear magnetic resonance spectroscopy ($^1\text{H-NMR}$) technique. The progress in polymerization was followed by measuring the integral of $-\text{O-CH}_2-$ in ϵ -CL and $-\text{O-CH}_2-$ in poly(ϵ -caprolactone) (PCL). The $^1\text{H-NMR}$ spectra showed the increasing intensity of $-\text{O-CH}_2-$ peak of PCL with polymerization time. The results showed that the propagation step proceeded by the insertion of monomer into the reactive tin-oxygen (Sn-O) bond. The polymerization rate was controlled by initiator concentration and found to increase with increasing concentration of initiator. Moreover, the dependency of activation energy (E_a) with initiator concentration obtained from this work was similar to differential scanning calorimetry (DSC) technique reported in our previous study. The polymerization mechanism was proposed through the coordination insertion mechanism. From the bulk polymerization at 120 °C, the molecular weight of the synthesized PCL was successfully controlled by concentration of $n\text{Bu}_3\text{SnOnBu}$.



Keywords Kinetics; Ring-opening polymerization; ϵ -Caprolactone; Tri-*n*-butyltin *n*-butoxide; $^1\text{H-NMR}$

Preparation of stable polymeric grafted layers on poly(ethylene terephthalate) by thermal annealing

Peerasak Paoprasert^{1*}, Warisara Boonthong¹, Chanatip Kookarinrat¹ and Nuanphun Chantarasiri²

¹*Department of Chemistry, Faculty of Science and Technology, Thammasat University, Pathumthani 12121, Thailand*

²*Supramolecular Chemistry Research Unit, Department of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand*

E-mail: peerasak@tu.ac.th

In this work, a simple, versatile grafting method for the preparation of stable polymer layers on poly(ethylene terephthalate) (PET) was demonstrated. Poly(styrene-*co*-2-hydroxyethyl methacrylate) was synthesized by free radical polymerization. The copolymer was grafted onto poly(ethylene terephthalate) via the hydroxyl groups upon thermal annealing. The grafting percentage of the copolymer was studied as a function of copolymer composition, PET surface treatment, annealing time, and annealing temperature. The grafted polymer layer on PET was stable over the immersion period in organic solvent whereas the non-grafted polymer layers were completely desorbed within two weeks. In addition, poly(4-vinylpyridine-*co*-2-hydroxyethyl methacrylate) was grafted onto PET in order to test the versatility of this grafting method. Control experiments were carried out to demonstrate that the grafting occurs through the available hydroxyl groups on the polymers and the surfaces. Based on these results, this grafting method offers a simple, versatile strategy for the preparation of stable polymeric layers on polymeric surfaces, and therefore, expands the tool box for functionalizing polymer surfaces.

Keywords Coatings; Adhesion; Grafting-to; Thermal annealing; Hydroxyl linker.

Prevulcanization of Natural Rubber Latex by using UV Radiation

Sirinapa Srisuk¹, Panithi Wiroonpochit^{2*} and Nanthiya Hansupalak³

¹*Interdisciplinary Graduate Program in Advanced and Sustainable Environmental Engineering,
Faculty of Engineering, Kasetsart University, Bangkok, 10900 Thailand*

²*National Metal and Materials Technology Center, 114 Paholyothin Rd., Klong 1,
KlongLuang, Pathumthani 12120 Thailand*

³*Department of Chemical Engineering, Faculty of Engineering, Kasetsart University, Bangkok, 10900
Thailand*

*E-mail: panithiw@mtec.or.th

As the conventional methods to prevulcanize natural rubber still face the problem of the skin allergy from the chemical residue. The radiation, such as ultraviolet (UV) or gamma rays, takes important role in forming the crosslinking between rubber molecules. It also does not cause chemical residue in products. However, the costs of high energy sources, such as gamma rays, is very high. In contrast, UV radiation technique is a cost saving process, less operational, and safety concerns. Thus, it is interesting to use for prevulcanize natural rubber (NR). In this work, UV light is used for prevulcanize high ammonia NR latex. The rubber chains are exposed to UV light by using α -hydroxyl ketone as a photoinitiator and using 1,9-bis (acryloyloxy) nonane or nonanediol as a coagent. The ratios of crosslinkers are varied to achieve the higher strength of the prevulcanizates. The investigated factors are UV irradiated time, mixing time, distances between UV lamps and latex surface, and thickness of latex. These have significant effects on the strength of prevulcanized rubber. The results of appropriate conditions reveal the increase of crosslink density, decrease of swelling ratio and the improvement of mechanical properties. The UV prevulcanized rubber film shows twice more crosslink density than the non-irradiated one.

Keywords Prevulcanization; Natural rubber latex; UV radiation

Silica Reinforcement of Chloroacetated Natural Rubber obtained by *In situ* Sol-gel Method

Natee Rongtongaram^{*}, Ploenpit Boochathum

Department of Chemistry, Faculty of Science, King Mongkut's University of Technology Thonburi, Bangkok, 10140, Thailand

**E-mail: natee.ron@hotmail.com*

Functionalized natural rubber with the prominent chloroacetate and hydroxyl groups as branches and minor epoxy groups (CNR) in the main chains was prepared. The silica-rubber composites were prepared in two methods: one method is sol-gel technique; by using tetraethoxysilane as the precursor for the in-situ generation of silica in the natural rubber latex (CNR-TEOS); the other is the addition of precipitated silica in dry CNR using two-roll mill (CNR-Si). The silica content of CNR-TEOS composite was identified to be 7.4 phr as measured by TGA. This is the same amount of the precipitated silica added in CNR-Si composite. Silica-rubber and rubber-rubber interaction of CNR-TEOS, CNR-Si and CNR were investigated from the elastic modulus measured using Rubber Processing Analyzer (RPA2000) at the strain sweep mode. It clarified that CNR-TEOS showed significantly higher silica-rubber interaction than CNR-Si whereas some rubber-rubber interaction was obvious for CNR due to the functionalities present in the natural rubber molecules. From FTIR spectra of CNR and CNR-TEOS composite, the hydrogen bond between carbonyl (-C=O) in chloroacetate group present in CNR and hydrogen atom in silanol group (Si-OH) present in silica was confirmed by the shift of -C=O peak from 1728 cm^{-1} for CNR to 1732 cm^{-1} for CNR-TEOS. Furthermore, *in situ* preparation of silica in CNR latex showed well-dispersion as well as well-distribution with averaged 240 nm in size of silica aggregates in the rubber matrix. These were believed to result in the improvement of the mechanical properties of CNR-TEOS vulcanizate over those of CNR-Si vulcanizate that CNR-TEOS vulcanizate showed excellent both tensile strength and elongation at break though 300% modulus slightly lower than that of CNR-Si vulcanizate. The reinforcement of *in situ* silica prepared in the chloroacetated natural rubber latex was found to be due to the interaction via hydrogen bond that resulted in the remarkably improved mechanical properties.

Keywords Chloroacetated natural rubber; Hydrogen bond; *In situ* sol-gel; Mechanical properties; Silica-rubber composite

Thermal behavior and Mechanical Properties of PLA in PLA filled with Coconut Residue

Chanchai Thongpin^{1*}, Nipasara Pinmuanrthong¹, Tanate Tubtimtong¹ and Pattarin Pannarangsri¹

¹*Department of Materials Science and Engineering, Faculty of Engineering and Industrial Technology, Silpakorn University, Sanamchandra Palace Campus, Nakornpathom, 73000, Thailand*

**E-mail: chanchai@su.ac.th*

The objective of this research was to utilize waste coconut residue from coconut milk industries, as filler in packaging. The nice property of coconut residue is its caramel scent during processing under heat. Poly (lactic acid), PLA, is an interesting plastic for this work as has good strength and biodegradable. The 2 grades of PLA, 2003D and 4043D were selected for comparison. The preparation was started with mixing dried PLA with dried coconut residue. The content of coconut residue was varied from 10, 20, 30 and 40 % by weight. The melt mixing of PLA and coconut residue was carried out in an internal mixer at 170 °C with the rotating speed of 60 rpm, for 15 minutes or until constant torque was reached. The composites of PLA/coconut residue, named as PLA/CNR, were then obtained and were further compressed in a compression molding machine at 170 °C with the pressure of 1000 psi. The crystallization thermal degradation of PLA in PLA/CNR was investigated using DSC and TGA, respectively. The PLA/CNR composites was cut into dumbbell shape and investigated for their tensile properties. The results showed that crystallinity of PLA in PLA/CNR composites was increased with the present of CNR. From SEM result, it was found that oil excluded from coconut meat was overwhelmed. This caused agglomeration of CNR in PLA matrix and hindered crystallization of PLA. For thermal stability, CNR induced thermal degradation of PLA in PLA/CNR composites. This is due to the low thermal stability of coconut oil and CNR. The tensile property of PLA/CNR composites showed that Young's modulus and elongation at break were slightly increased at 10% CNR. Both properties started to decrease with the high content of CNR. Tensile strength of PLA/CNR was found decreased with the content of CNR. This is thought to be the plasticization of PLA by the excluded coconut oil during heating and shearing in the internal mixer. The caramel aroma of heated coconut was also investigated using sensory evaluation based on affective or hedonic test. It was found that the respondents were satisfied with the aroma released from the composite. This was the primarily test encouraging the utilization of the composites for Thai desert packaging material.

Keyword PLA/Coconut residue; Thermal stability; Crystallization; Tensile strength; Coconut aroma released

Preparation and Characterization of Chitosan Composite Films for use in Anti-electrostatic Discharge Application

Weerachon Srihata¹, Ubolluk Rattanasak¹ and Supranee Keawpirom^{1*}

¹*Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Burapha University, Bangsaen, Chonburi, 20131, Thailand.*

**E-mail: kaewpiro@buu.ac.th*

Graphene oxide (GO) and reduced graphene oxide (RGO) were used as conductive fillers to produce conductive composites based on chitosan. Chitosan, CS/GO and CS/RGO composites were prepared by solution blending, using 0.00, 1.96, 3.35, 5.66, 7.40, 9.09, 16.67 and 23.08 wt.% of filler. The obtained products were characterized by Scanning electron microscopy, Fourier transform infrared spectroscopy, and X-ray powder diffraction. The mechanical properties and electrical resistivity of such the products were also investigated. A significant synergistic effect of GO and RGO provided enhanced electrical resistivity, mechanical properties, and thermal stability on the polymer composite films. The thermal stability and mechanical properties of polymer composite films were also improved, compared with the neat CS. The electrical resistivity of CS was $3.29 \times 10^8 \Omega \cdot \text{cm}$, and when a fillers were loaded into the polymer composite films, the electrical resistivity was reduced from $3.29 \times 10^8 \Omega \cdot \text{cm}$ to 1.24×10^8 and $8.61 \times 10^5 \Omega \cdot \text{cm}$ at 23.08 wt.% of GO and RGO, respectively. Therefore, the prepared composite films can be potentially used in anti-electrostatic discharge applications.

Keywords Chitosan; Anti-electrostatic discharge; Graphene oxide; Reduced graphene oxide; Composites

Comparison of Scratch Resistance in Polypropylene Compounded with Talc and α -Nucleating Agent

Pichamon Ongsritrakul¹, Nawadon Petchwatana² and Irijutaratana Covavisaruch^{1*}

¹*Department of Chemical Engineering, Faculty of Engineering,
Chulalongkorn University, Bangkok, Thailand*

²*Division of Polymer Materials Technology, Faculty of Agricultural Product Innovation
and Technology, Srinakharinwirot University, Bangkok, Thailand
Phone: +66-2218-6876, *E-mail: sirijutaratana.c@chula.ac.th*

PP is a versatile thermoplastic for automotive interior parts but it still suffers the problem of susceptibility to scratch and mar damages, an issue of high concern to automotive manufacturers. This study investigated the use of talc as filler and alpha-nucleating agent (α -NA) to promote scratch resistance in PP. Two series of PP compounds were prepared, one filled with 15 to 25% talc and the other nucleated with 0.1 to 0.5 wt% α -NA. A scratch test was performed by using Multi-finger scratch/mar tester with 10 N compressive load. Scratch evaluation in the form of scratch depth and width by using profilometer revealed that all the PP/talc exhibited scratches with greater depth as talc content increased. The addition of 25 wt% talc led to scratches with depth doubling that in the unfilled PP. The α -NA was found more effective in resisting scratches; this was verified by the significant reduction of the scratch depth from 5.2 μm in the unfilled PP to 3.5 μm when only 0.3wt% α -NA was employed. The width of all scratches in PP/talc and PP/ α -NA compound remained close to that of the unfilled PP. The enhanced resistance to scratch of the PP/ α -NA was believed to arise from its greater Rockwell hardness of 70-73.6 as compared with 65.4 of the unfilled PP and 58.2 to 63.3 of PP/talc, The increase hardness was a result of higher crystallinity promoted by α -NA. Analysis by Differential Scanning Calorimeter (DSC) indicated the maximum degree of crystallinity at 42% in PP/ α -NA with only 0.3% α -NA as compared with 27-36% found in PP/talc and unmodified PP. The crystallization temperature (T_c) was found to increase with α -NA content; indicating that α -NA induced early crystallization and led to a greater crystallinity. Mechanical tests in terms of tensile and flexural properties revealed that the modulus of all the PP/ α -NA remained close to that of the unfilled PP while those of the PP/talc increased significantly.

Keywords Polypropylene; Talc; Alpha-nucleating agent; Scratch resistance; Mechanical properties

Improvement of Ethylene Permeation in LLDPE/SEBS Film with Zeolite Y

Thanaporn Sahassanon¹, Suparat Rukchonlatee¹, Tawan Sooknoi² and Chonlada Ritvirulh^{1*}

¹*Polymer Synthesis and Functional Materials Research Unit/ Department of Chemistry, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand*

²*Catalytic Chemistry Research Unit/ Department of Chemistry, Faculty of Science, King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand*

*E-mail: krchonla@kmitl.ac.th

Polymer blend films based on linear low density polyethylene (LLDPE)/poly(styrene-ethylene-butylene-styrene)(SEBS) at the 70/30 weight ratio were studied in this research. The zeolite Y filler, a solid porous material, was incorporated in the blend to improve ethylene gas permeation. The compounds were prepared via melt blending in an internal mixer and the films were shaped using a compression molding process. Zeolite Y contents in the blends were varied at 5, 10, 15 and 20% by total weight of polymer. In addition, the LLDPE/SEBS blends with silica or calcium carbonate (non porous fillers) were also prepared. The results of ethylene transmission rate (ETR) of the films revealed that an incorporation of zeolite Y could give higher ETR than the use of calcium carbonate. This was due to high porosity in nature of zeolite Y. However, the LLDPE/SEBS film with silica had greater ETR than that with zeolite Y. This was attributed to defects in the silica-filled film. To increase the ETR of the zeolite Y-filled film, the polarity of the zeolite Y should be reduced. This was done by surface treatment of zeolite Y with octadecyltrichlorosilane (OTS). At 5% filler loading, the film with modified zeolite Y gave ETR higher than that with non-modified one. This is because of an increase in hydrophobicity of the modified zeolite Y. At higher loadings, the ETR of the modified zeolite Y-filled film did not change significantly. However, the ETR of the non-modified zeolite Y-filled film increased when the content of zeolite Y is increased. This is due to an increase in interfacial void between polymers and the zeolite. Additionally, mechanical properties (tensile strength at break, elongation at break and Young's modulus) of the films at 5-20% filler loadings were improved when the OTS-modified zeolite Y was used.

Keywords LLDPE; SEBS; Polymer blend; Zeolite; Ethylene permeation

Development of Platinum Nanoparticles on Surface-modified Polyimide Films for Methanol Electro-oxidation

Rungnahpa Rungsariyanon¹, Kensuke Akamatsu² and Parichatr Vanalabhpatana^{3*}

¹*Program of Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand*

²*Department of Nanobiochemistry, Frontiers of Innovative Research in Science and Technology, Konan University, Kobe 650-0047, Japan*

³*Department of Chemistry, Faculty of Science, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand*

**E-mail: parichatr.v@chula.ac.th*

Platinum nanoparticles on polyimide films have been prepared via a surface modification and ion-exchange process. Initially, the polyimide film surface was chemically modified by a potassium hydroxide solution to introduce carboxylate moieties that can incorporate platinum ions, followed by chemical reduction to yield platinum nanoparticles impregnated on polyimide films. The obtained platinum nanocomposite films were characterized using various techniques such as scanning electron microscopy, X-ray diffraction analysis, and cyclic voltammetry. Inductively coupled plasma-optical emission spectroscopic results revealed that platinum ions were stoichiometrically attached to the modified polyimide layer through an ion-exchange reaction with potassium ions in a 1:2 molar ratio. Electrochemical experiments demonstrate that the nanocomposite films are capable of catalyzing the electro-oxidation of methanol. Film optimization and electrochemical application will be further discussed.

Keywords Platinum Nanoparticles; Polyimide Film; Methanol Electro-oxidation

Mechanical Properties and Oil Swelling Resistant of Natural Rubber/Montmorillonite Composites Prepared from Latex Compounding Method

Duy Le¹, Boonyawan Yoosuk² and Suwadee Kongparakul^{1*}

¹*Department of Chemistry, Faculty of Science and Technology, Thammasat University, Pathumthani, 12120, Thailand*

²*National Metal and Materials Technology Center (MTEC), Pathumthani, 12120, Thailand*

**E-mail: ksuwadee@tu.ac.th*

Natural rubber (NR)/montmorillonite (MT) composites was prepared via latex compounding method using sulfur vulcanization system. NR latex was firstly mixed with MT (surface area 20-40 m²/g) aqueous dispersion and then subsequently added vulcanizing ingredients. Latex compound was transferred into a glass mold and vulcanized at 100°C for 20 min. The influences of MT loading on mechanical properties and swelling behaviour of composites were investigated. The results showed tensile strength and elongation at break of NR/MT composites were slightly decreased with an increase in MT content while modulus at 100% and 300% were increased. Mechanical properties of the compounds were depended on particles size and extent of MT particles dispersion into the rubber matrix. Oil swelling behaviour of the composites showed maximum oil resistant was obtained from the composites contained 5 phr of MT. Thermal stability of NR/MT composites was also determined and discussed.

Keywords Natural rubber; Montmorillonite; Composites; Mechanical properties; Oil swelling

The Optimal Degumming Process for Silk Sericin Powders and Its Fabrication into A Semi-IPNs Gel Scaffolds

Jinjutha Daengmankhong¹, Sukhonthamart Sornjun¹, Rosjares Bunpum¹
Saratat Mahasaranon¹, Gareth M. Ross^{1,2}, Sukunya Ross^{1*}

¹ Biopolymer Research Group, Department of Chemistry and Biomaterials Center of Excellence, Faculty of Science, Naresuan University, Phitsanulok, 65000, Thailand

² Lower Northern Science Park, Naresuan University, Phitsanulok, 65000, Thailand

*E-mail: sukunyaj@nu.ac.th

This work concentrated on finding the best method and conditions for degumming sericin, which is a water-soluble protein, derived from both white and yellow *Bombyx mori* silk cocoons. We then incorporated the sericin into semi-interpenetrating network (semi-IPNs) gel scaffolds. The hot water and base sodium carbonate degumming processes were compared, using different times and temperatures. The hot water degumming process showed a lower efficiency to extract sericin from the silk fibers when compared to the base method, but purification of the product is not required. Therefore, the simple hot water degumming process was chosen for further study. The optimum condition for yielding the most sericin powders was 100 °C for 4 hrs and this generated 17 wt% (white cocoons) and 24 wt% (yellow cocoons). A semi-IPNs hydrogel was prepared by redox polymerization of silk sericin powders and hydroxyethyl methacrylate (a monomer) in the presence of N,N'-methylene bisacrylamide as a crosslinker. The effect of the amount of crosslinker in the polymerized system on the physical and mechanical properties was examined. The chemical structure of the sericin powder was determined by Fourier transform infrared spectroscopy and nuclear magnetic resonance spectroscopy. The thermal properties, morphology, *in vitro* degradation, swelling behavior and the cell culture test of semi-IPNs hydrogel were also investigated. It was found that physical and mechanical properties of the samples were strongly depended on the amount of not only the crosslinker but also sericin. The benefits of this work can be used in biomedical applications, such as for the skin reconstruction scaffolds.

Keywords Sericin; Scaffold; Semi-IPNs hydrogel; Hydroxyethyl methacrylate