PROGRAM DETAILS

ORAL Presentation Program of AWPP2009

December 02 (Wed.), 2009

*** Kindly click the program code/title to read the abstract**

	Grand Ball Room		Salon III & Salon IV	
08:50	Registration (Foyer of Grand Ball Room)			
09:20	Opening Ceremony (Grand Ball Room)			
09:35-10:35	[Plenary Lecture : Malaysia] (Grand Ball Room) **Fumihiko Konishi** (Texchem Group, Malaysia) The Role and Contributions of Polymer Processing in the History of Malaysian Plastics Industry and its Development **Chairperson: Prof Masahiro Ohshima**			
10:35	Break Time & Exhibition (Foyer of Grand Ball Room)			
	Grand Ball Room			**Salon III and Salon IV**
	Extrusion & Compounding **Chairperson:** **Associate Prof Dr Azhar b. Abu Bakar** **Prof. Tadamoto Sakai**			**Rheology & Rheometry** **Chairperson:** **Dr. Zulkifli b. Mohamad Ariff** **Dr. Takeharu Isaki**
10:50-11:20	A-101	[KEYNOTE A1] **Hiroyuki Kobayashi** (Polyplastics Co.Ltd) Recent Innovations in High Performance Engineering Plastics	10:50-11:10	B-101 **Masayuki Yamaguchi** (JAIST, Japan) Structure and rheological properties of binary blend of polypropylene and acrylic modified PTFE
11:20-11:40	A-102	**Tadamoto Sakai** (Shizuoka University) Recent Progress in Melt Compounding Technology for PNC Using a Twin Screw Extruder	11:10-11:30	B-102 **Robert Marsh** (Malvern Instruments) Rheology of Heterogeneous Polymer Melts
11:40-12:00	A-103	**Winyu Tanthapanichakoon** (Thai Polyethylene Co. Ltd.) Melt Index Change of HDPE-CB Composite during Compounding and Profile Extrusion	11:30-11:50	B-103 **Piyawit Koombhongse** (MTEC, Thailand) Plasticizing Effect and Electrospinability of Chitosan Derivatives/PVA
12:00-12:20	A-104	**Chan Kah Fai** (Texchem Polymer Sdn Bhd) The Role of Organoclay on the Flow Behavior and Electrical Properties of Carbon Nanotube/ Polymer Composites	11:50-12.20	B-104 [KEYNOTE B1] **Masataka Sugimoto** (Yamagata Unviersity) Rheological Behavior and Structure of Multi-component Polymer System
12:20-12.40	A-105	**Yee Kok Leong** (Toray Plastics (M) Sdn Bhd)		

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		Transparent grade ABS- an alternative to other existing similar grade of transparent or translucent plastics material	12:20-12:50	B-105	[KEYNOTE B2] **Charoen Nakason** (Prince of Songkla University) Rheological of Natural Rubber Blends: Compatibilization, Co-continuity prediction and Phase inversion detection
12:40-13.00	A-106	**Sahrim Ahmad** (Universiti Kebangsaan Malaysia) Processing of Rubber Toughened Epoxy Nanocomposites			
	Lunch Break (G Café)				
14:00-14:30	**Grand Ball Room** **Fiber Spinning & Film** **Chairperson:** **Associate Prof. Dr. Azlan b. Ariffin** **Associate Prof. Hiroshi Ito**		14:00-14:20	**Salon III and Salon IV** **Novel Material & Processing & Process Optimization 1** **Chairperson:** **Professor Lam Yee Cheong** **Associate Prof. Seiichi Kawahara**	
	A-107	[KEYNOTE A2] **Takeharu Isaki** (Mitsui Chemicals) Simulations of pelletize, flat die and film casting with rheological properties.		B-106	**Chantara Thevy Ratnam** (Agensi Nuklear Malaysia) Radiation Processing of Natural Rubber
14:30-14:50	A-108	**Masayuki Haruta** (Toyobo Co. Ltd.) Study on stretching methods of biaxially stretched co-polyester film that has uniaxially heat shrinkage property	14:20-14:40	B-107	**Hiroto Murakami** (Nagasaki University) Thermal properties of side chain crystalline acryl polymers
14:50-15:10	A-109	**Toshiro Yamada** (Kanazawa University) Measurement of Diffusion Coefficient of Acetone in Cellulose Acetate for a Dry Spinning Process	14:40-15:10	B-108	[KEYNOTE B3] **Shu-Lin Bai** (Peking University) Application of nanoindentation method to different materials and relevant affecting parameters
15:10-15:30	A-110	**Sasitorn Au-jean** (Klöckner Pentaplast (Thailand) Ltd) New Pharmaceutical Packaging Trend and kp High Barrier Films Innovation	15:10-15:40	B-109	[KEYNOTE B4] **Krisda Suchiva** (MTEC, Thailand)
	Break Time (Foyer of Grand Ball Room)				
15:45-16:15	**Grand Ball Room** **Nanotechnology** **Chairperson:** **Associate Prof Dr Mariatti bt. Jaafar** **Associate Prof. Masaya Kotaki**		15:45-16:05	**Salon III and Salon IV** **Recycle and Environmental Techniques** **Chairperson:** **Dr Nadras bt. Othman** **Associate Prof. Yoichi Tominaga**	

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	A-111	[KEYNOTE A3] **Jang-Kyo Kim** (Hong Kong Univ. of Sci. & Tech.) Conductive polymers containing hybrid carbon nanotubes, carbon black and graphite nanoplates		B-110	**Azman Hassan** (Universiti Teknologi Malaysia) Preparation and Characterization of LLDPE Toughened Polylactic Acid
16:15-16:35	A-112	**Zhang Xiwen** (Kyoto Institute of Technology) Stereocomplex Formation of Poly(L-lactide) and Poly(D-lactide) via Electrospinning	16:05-16:25	B-111	**Manisara Phiriyawirut** (KMUTT, Thailand) Alpha-chitin Reinforced Tapioca Starch-based Composite Foam
16:35-16:55	A-113	**Jessada Wong-on** (Pathumwan Inst. of Technology) Toughening of Polypropylene by elastomeric nano-particles	16:25-16:45	B-112	**Smith Thitithanasarn** (Kyoto Institute of Technology) Mechanical Performance Evaluation of Natural Fiber Reinforced Poly(lactic acid) Textile Insert Moldings
16:55-17:15	A-114	**Yoshihiro Yamashita** (The Univ. of Shiga Prefecture) Electrospinning Technique and View to the Mass Production of Nanofiber	16:45-17:05	B-113	**Sapuan Salit** (Universiti Putra Malaysia) Heat treatment and recyclability of sugarcane bagasse reinforced PVC composites
17:15-17:35	A-115	**Shinsuke Nagamine** (Kyoto University) Hollow TiO_2 Microstructures Templated by Electrospun Droplets of Polymer Aqueous Solutions	17:05-17:25	B-114	**Ishak Ahmad** (Universiti Kebangsaan Malaysia) Unsaturated Polyester Resin from Poly(ethylene terephtalate) waste: Effects of liquid natural rubber and glass fiber mats on its properties
17:35-17:55	A-116	**Seiichi Kawahara** (Nagaoka Univ. of Technology) Morphology and Mechanical Properties of Soft Material with Nano-matrix Structure	17:25-17:45	B-115	**Prayoon Surin** (KMUTT, Thailand) The green composites from coil fiber and poly(lactic acid): Physical and mechanical properties evaluation
18:00-19:00	Poster Presentation (Foyer of Grand Ball Room)				
19:00	Break Time				
19:30-22:00	Banquet (Grand Dinner of AWPP2009)				

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ORAL Presentation Program of AWPP2009

December 03 (Thu.), 2009

	Grand Ball Room		Salon III and Salon IV	
08:30	Registration (Foyer of Grand Ball Room)			
09:00-10:00	[Plenary Lecture : Japan] (Grand Ball Room) Toshitaka Kanai (Idemitsu Kosan Co. Ltd., Japan) Evaluation of Structure Development and Stretchability during the Stretching Process for Various Polypropylenes **Chairperson: Prof Rozman Hj. Din**			
10:00	Break Time (Foyer of Grand Ball Room)			
10:15-10:45	**Grand Ball Room** **Injection Molding 1** **Chairperson:** **Associate Prof. Dr. Charoen Nakason** **Dr. Yew Wei Leong**		10:15-10:35	**Salon III and Salon IV** **Alloys, Blend and Composites** **Chairperson:** **Professor Jang-Kyo Kim** **Associate Prof. Asami Nakai**
	A-201	[KEYNOTE A4] **Hidetoshi Yokoi** (The University of Tokyo) Recent Progress of In-mold Visualization Technologies for Fine Pattern Replication Process in Injection Molding		B-201	**Masayuki Yamaguchi** (JAIST, Japan) Structure and mechanical properties for PLA blends having fibrous dispersion
10:45-11:05	A-202	**Daisuke Yoshida** (The University of Tokyo) High-Magnification Visualization of Melt Filling Behaviors in Fine-Pattern Replication Molding using New Microscope-Installed Mold	10:35-10:55	B-202	**Hiroshi Ito** (Yamagata University) Structure and thermal property of Al_2O_3 fiber filled composites in injection compression molding
11:05-11:25	A-204	**Ichirou Nishi** (Kyoto Institute of Technology) New functions of thermoplastic elastomer based sandwich injection moldings	10:55-11:15	B-203	**Azanam Shah Hashim** (Universiti Kuala Lumpur) Styrene-Modified Natural Rubber as Compatibilizer/Modifier for Some PP-Based Blends
11:25-11:45	A-206	**Koji Yamada** (Osaka Municipal Technical Research Institute) Evaluation of molecular orientation in injection molded polypropylene	11:15-11:45	B-204	[KEYNOTE B5] **Rozman Hj. Din** (Universiti Sains Malaysia) The effect of chemical modification of montmorillonite on tensile and flexural properties of ultra-violet radiation-cured biocomposites from kenaf

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11:45-12:05	A-207	**Warunee Klinklai** (Rajamangala University of Technology) Development a Plastic Waste from Soft Drink Bottle Polyethylene terephthalate for Textile Fiber Application	11:45-12:05	B-205	**Aziz Hassan** (Universiti Malaya) Thermal and Mechanical Properties of Injection Moulded Short Glass/Short Carbon Hybrid Fibre Reinforced Polyamide 6,6, Composites
12:05-12:25	A-208	**Patcharee Larpsuriyakul** (MTEC, Thailand) Comparison of 2.5D and 3D Injection Molding Simulation of Flat Plates with Non-Uniform Part Thickness	12:05-12:25	B-206	**Supaporn Thumsorn** (Kyoto Institute of Technology) On the Paintability of Injection Molded Recycled PET/Recycled PP Blend filled with $CaCO_3$
12:25-12:45			12:25-12:45	B-207	**Toshiyuki Yasuhara** (Tokyo Institute of Technology) Improvement of mechanical properties of CNT-composites with high aspect ratio CNT
12:45-13:05			12:45-13:05	B-208	**Puteri Sri Melor Megat Yusoff** (Universiti Teknologi Petronas) Assessment of Fiber Damage during Processing and its Relation to Mechanical Properties of Natural Fiber Reinforced Plastics
13:05	Lunch Break (G Café)				
14:00-14:30	**Grand Ball Room** **Structure and Properties, and their Evolution** **Chairperson:** **Associate Prof. Dr. Hazizan b. Md. Akil** **Associate Prof. Atsushi Yokoyama**		14:00-14:20	**Salon III and Salon IV** **Emerging Polymer Processing Technologies** **Chairperson:** **Dr Zulkifli b. Ahmad** **Associate Prof. Takushi Saito**	
	A-209	[KEYNOTE A5] **Lam Yee Cheong** (Nanyang Tech. University) Simulation and Optimization of Plastic Injection Molding		B-209	**Ng Chee Mang** (Penchem Technologies Sdn Bhd) LED Encapsulation using Epoxy and Silicone
14:30-14:50	A-210	**Masayuki Yamaguchi** (JAIST, Japan) Orientation birefringence of cellulose ester	14:20-14:40	B-210	**Rahmah Mohamed** (University Technology MARA) Fabrication techniques of polymeric material for microelectronic and photonic applications
14:50-15:10	A-211	**Nurhafizah Abd Rahman** (Kanazawa University) Influence of morphology on uniaxial tensile behavior of polyoxymethylene	14:40-15:10	B211	**Chee Choong Kooi** (Intel Malaysia) Small is beautiful – Innovations in Microelectronics Packaging Miniaturizations

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15:10-15:30	A-212	**Hiroyuki Nishimura** (Osaka Gas) Evaluation of long-term performance of plastic pipes for hot water supply	15:10-15:30	B-212	**Patcharat Wongsriraksa** (Kyoto Institute of Technology) On the Combination of Braiding and Weaving Technologies for Fabricating Continuous Natural Fiber-Reinforced Composites
15:30	Break Time (Foyer of Grand Ball Room)				
15:45-16:05	**Grand Ball Room** **Injection Molding 2** **Chairperson:** **Associate Prof. Dr. Chow Wen Shyang** **Dr. Koji Yamada**		15:45-16:05	**Salon III and Salon IV** **Novel Material & Processing & Process Optimization 2** **Chairperson:** **Dr Azura bt. A. Rashid** **Dr. Hiroyuki Nishimura**	
	A-213	**Keun Park** (Seoul Nat. University of Tech.) Applications of High-Frequency Induction Heating to High-Quality Injection Molding		B-213	**Tan Yee Chech** (PETRONAS Research) Mechanical and Bonding Behaviour of Polymeric Grout as a Function of Temperature and Surface Conditions
16:05-16:25	A-214	**Lei Ti Huang** (The University of Tokyo) Visual Analysis of Gate Flow Phenomenon in High Speed Injection Process	16:05-16:25	B-214	**Takushi Saito** (Tokyo Institute of Technology) Laser Transmission Welding Technique Utilizing Change of Absorption Coefficient of Material by Moisture Adsorption
16:25-16:45	A-215	**Atsushi Yokoyama** (Kyoto Institute of Technology) Multiple Optimum Design for Injection Molding Die by Nonlinear Approximation Technique	16:25-16:45	B-215	**K. Tokumitsu** (The Univ. of Shiga Prefecture) The Effect of Adding Polysilane into Polyolefins
16:45-17:05	A-216	**Hirohito Kai** (The University of Tokyo) Measurement of Melt Temperature Distributions in Y-shaped Runner Split Zone Using New Measuring Mold with Round Rotary Block Structure	16:45-17:05	B-216	**Lai Seng Heng** (Titan Petchem (M) Sdn Bhd) Super High Clarity PP for Baby Feeding Bottle & Sport Drink Bottle
17:15-17:45	Closing Ceremony (Grand Ball Room)				

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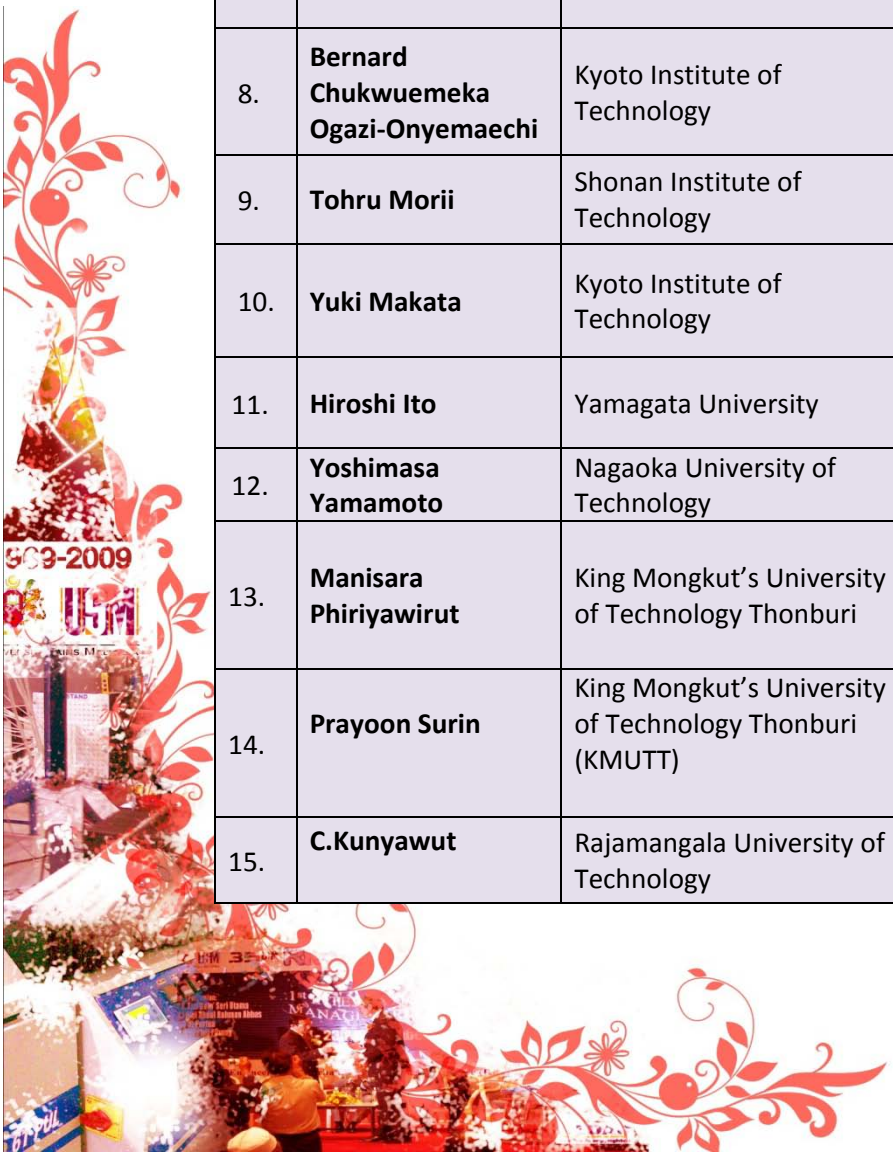
Poster Presentations:

No.	Presenter	Affiliation	Title
1.	**Hitoshi Takagi**	Tokushima University	Mechanical properties of cellulose
2.	**Yoichi Tominaga**	Tokyo University of Agriculture and Technology	Development of Solid Polymer Electrolytes Using Supercritical Carbon Dioxide
3.	**Katsuhiro Kodama**	Toyobo Co. Ltd.	The study of surface properties in injection moldings
4.	**Katsuhiro Kodama**	Toyobo Co. Ltd.	The study on the influence of a resin temperature and pressure on the surface properties of the injection moldings
5.	**Rahida Wati Sharudin**	Kyoto University	PP/PS/PMMA (80/10/10) Ternary Polymer Blend Foaming: Morphology and Cell Structure
6.	**Vadee Chivatanasoontorn**	Kyoto Institute of Technology	Effect of Surface Texture on Scratch Behavior of Injection Molded Plastics
7.	**Siti Fatimah Aminuddin**	Kyoto Institute of Technology	Pellet morphology during the compounding process of recycled poly(ethylene terephthalate)/ recycled polypropylene blends
8.	**Bernard Chukwuemeka Ogazi-Onyemaechi**	Kyoto Institute of Technology	Impact Fracture Modes of Hairline-cracked Injection Moldings of Recycled Polyethylene Terephthalate
9.	**Tohru Morii**	Shonan Institute of Technology	Hydrothermal aging of jute/PP injection moldings
10.	**Yuki Makata**	Kyoto Institute of Technology	Influence of Particle Size on Filler Dispersion in PMMA/Silica Micro Injection Moldings
11.	**Hiroshi Ito**	Yamagata University	Fabrication of Micro-pattern of Quartz Glass in Injection Molding Process
12.	**Yoshimasa Yamamoto**	Nagaoka University of Technology	Mechanical Properties of Nano-matrix structured Material
13.	**Manisara Phiriyawirut**	King Mongkut's University of Technology Thonburi	Preparation of Natural Rubber Fine-powder from Electrospinning for Polymer Toughness Modifier
14.	**Prayoon Surin**	King Mongkut's University of Technology Thonburi (KMUTT)	A study on effect of hardener for prepared composite wood from glutinous rice flour
15.	**C.Kunyawut**	Rajamangala University of Technology	Study of High Voltage Insulator using Natural Rubber



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16.	**Piyapong Buahom**	King Mongkut's Institute of Technology Ladkrabang	Characterization of Cell Density with Principle of Critical Bubble Lattice and Variation of Cell Cross-Sections for Isotropic Polymeric Foams
17.	**Natcha Prakymoramas**	National Metal and Materials Technology Center (MTEC)	The Influence of Mold Temperature on Mechanical Properties of Rigid Polyurethane Composite Foam
18.	**Phua Yi Jing**	Universiti Sains Malaysia	Effect of Uniaxial Cold Rolling on the Structure and Properties of Poly(Butylene Succinate)/Organo-Montmorillonite Nanocomposites
19.	**Tham Wei Ling**	Universiti Sains Malaysia	Water Absorption of Poly(methyl methacrylate)/Hydroxyapatite Composites
20.	**Rafiza Ramli**	Penchem Industry Sdn Bhd	Synthesis of aromatic side-chain modification of polysiloxane for high refractive index
21.	**Nurul Mujahidah Ahmad Khairuddin**	Universiti Sains Malaysia	Effect of Alkali Treatment on the Mechanical Properties of Polypropylene-Kenaf Fiber Composites
22.	**Adlan Akram Bin Mohamad Mazuki**	Universiti Sains Malaysia	Environmental Degradation Study of Pultruded Jute Fibre Reinforced Unsaturated Polyester Composites Using Dynamic Mechanical Thermal Analysis
23.	**Mohd Firdaus Bin Omar**	Universiti Sains Malaysia	Measurement of Dynamic Mechanical Properties of Pultruded Natural Fibre Reinforced Composites Using Split Hopkinson Pressure Bar Apparatus (SHPBA)
24.	**Yusriah Lazim**	Universiti Sains Malaysia	Comparison on the properties of phenolic hollow microspheres (PHMS)/ woven glass fabric and woven basalt fabric filled vinyl ester composites
25.	**Hamizah Abd Samad**	Universiti Sains Malaysia	Properties of bioactive fillers filled PMMA bone cement
26.	**Siti Salmi Binti Samsudin**	Universiti Sains Malaysia	Processing and Compressive Strengths of Epoxy Syntactic Foam Incorporated with Epoxy Hollow Spheres
27.	**Nor Azura Binti Abdul Rahim**	Universiti Sains Malaysia	Flow behavior of polypropylene-kaolin composites at various filler loading, temperatures and multiple extrusion cycle
28.	**Razif Bin Muhammed Nordin**	Universiti Sains Malaysia	Tensile Properties and Morphology of Lldpe/Pva Blends Containing 3-(Trimethoxysilyl)Propyl Methacrylate As Coupling Agent

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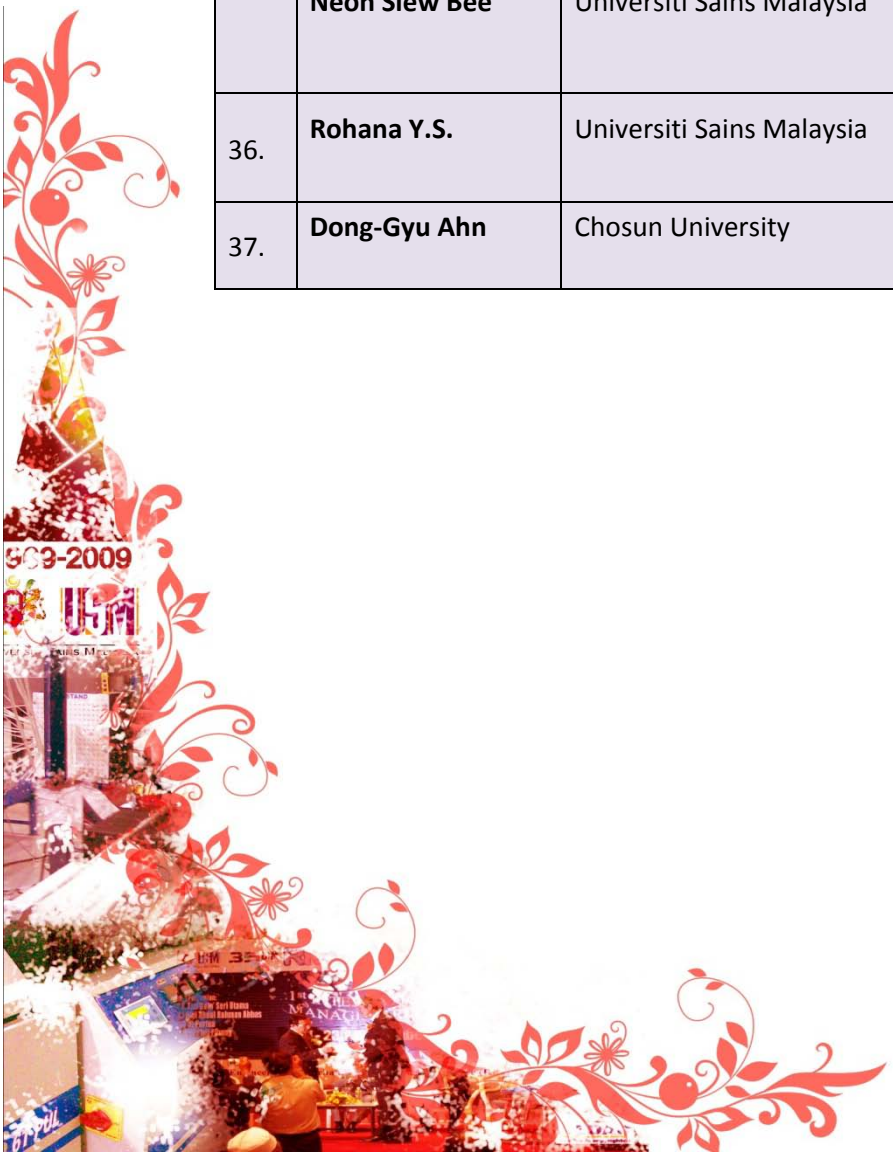
29.	**Nur Diyana Mohamad Zaharri**	Universiti Sains Malaysia	Effect of Silane Coupling Agent on Mechanical and Morphological Properties of Polypropylene/Zeolite Composite
30.	**Nur Azleen Bt Azahari**	Universiti Sains Malaysia	Water absorption study on PVA/corn starch blend composites
31.	**Sam Sung Ting**	Universiti Sains Malaysia	The Effect of Electron beam irradiation on Mechanical Properties of ENR compatiblized LLDPE/soya powder blends
32.	**Lim Su Rong**	Universiti Sains Malaysia	Fracture Toughness and Optical Properties of Epoxy/Organo-Montmorillonite Nanocomposites
33.	**Chang Lee Nah**	Universiti Sains Malaysia	Mechanical and Morphological Properties of Epoxy Clay Hybrid Nanocomposites
34.	**Tay Hong Kang**	Universiti Sains Malaysia	Effects of Hygrothermal Aging on Jute/Glass Fibers Reinforced Unsaturated Polyester Composites: Visual Appearance and Morphological Properties
35.	**Neoh Siew Bee**	Universiti Sains Malaysia	Effect of different curing system on physico-mechanical and morphological of in situ vulcanization process of styrene-modified natural rubber (SNR)
36.	**Rohana Y.S.**	Universiti Sains Malaysia	The Effect Of Ageing On Permeability Behavior Of Toluene Through Natural Rubber
37.	**Dong-Gyu Ahn**	Chosun University	Design of Thermal Management Mould for Computer Mouse



ABSTRACTS FOR KEYNOTES

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"The Role And Contributions Of Polymer Processing In The History Of Malaysian Plastics Industries And Their Developments."

Tan Sri Dato' Seri Fumihiko Konishi

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The plastics industries in Malaysia saw a revolutionary reform after the introduction of new polymer processing technology. Immediately upon acquiring the know-how of such a new technology, the Malaysian plastics industries experienced a whole new competitive landscape.In this new development, a few parties have played key roles in facilitating and nurturing the industries; both private sectors and the Malaysian government through its agencies such as MITI (Malaysian International Trade & Industry) and MIDA (Malaysian Industrial Development Authority) have acted in consent as incubators for the industries to grow and helped in technology transfer from advanced country such as Japan.Polymer processing industries in Malaysia will further strengthen through a more active partnership with government, educational institutions and polymer industry players as a whole. It is the fervent wish of the plastics industries in Malaysia that the Japanese Polymer Processing Society can help to elevate the technology standard a step further, and bring mutual benefit to both countries.

Keywords: Polymer Processing, Malaysia, Plastic Industries.

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Evaluation of Structure Development and Stretchability during the Stretching Process for Various Polypropylenes

T. Kanai*, T. Takebe, N.Matsuzawa, H. Yamaguchi
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The structure development and stretchability of polypropylene (PP) during the stretching process were evaluated by using the light scattering, the birefringence, the small angle X-ray scattering (SAXS).and the stretching force measurement system. As samples of polypropylenes, molecular weight distribution and tacticity were changed. Furthermore, very low tacticity polypropylene was added to the standard stretching polypropylene grade. As a result, the stretchablity, the thickness uniformity and stress development could be evaluated for high speed stretching or thin stretching film forming. Low tacticity influences spherulite size and lamella thickness and decreases yield value of stretching force which prevents film break and improve film thickness uniformity. Wide molecular weight distribution decreases stretching stress at high stretching ratio. Blending of very low tacticity portion decreases crystallinity and both yield value and final stress. Reduction of yield value and stress at the high stretching strain prevents film break and gives uniform thickness. The stretchablity and structure development can be predicted using only a small amount of samples.

Keywords: Stretchability, Polypropylene, Structure Development, Tacticity

ABSTRACTS FOR ORAL PRESENTATION

[Open full paper] **A-101** [Back to abstract list]

Recent Innovations in High Performance Engineering Plastics

Hiroyuki Kobayashi

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Some of new polymers and compounds for engineering plastics have been developed with technical innovations. In this workshop, recent topics in engineering plastics will be introduced: for instance, low chlorine polyphenylene sulfide (PPS) grade, polyoxymethylene (POM)/cellulose composites, glow-wire ignition temperature (GWIT) improvement polybutylene terephthalate (PBT) grade, high thermal conductive plastics and so on.

Keywords : Engineering Plastics, Environmental Considerations, High Performance, Recent Innovations

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Recent Progress in Melt Compounding Technology for PNC Using a Twin Screw Extruder

Tadamoto Sakai,

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Polymer nano-composites (PNC) have been greatly highlighted for the applications to various kinds of polymer related industries, in particular, for automobile parts and food packages. The main differences between new nano-fillers for PNC and conventional ones are the filler size (1-200 nanometers for PNC) and the filling concentration (1-7 wt% for PNC). Commercial PNC (PA type) has been first produced by a polymerization process. However, various melt compounding methods have been developing mainly to reduce the production cost. The most important key point in melt compounding is how to intercalate and exfoliate clay platelets without severe thermal and mechanical degradation in both the polymer and additives. In this paper recent progresses in melt-compounding technology using a twin screw extruder were reviewed.

Keywords: Polymer Nano-composite, melt compounding, twin screw extruder, mixing,

[Open full paper] **A-103** [Back to abstract list]

Melt Index Change of HDPE-CB Compound by Degradation

Tanthapanichakoon W.[1], Bennaceur W.[2], Promvijit P.[3], Samaisong A.[4], Katchamart S.[1]

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[3] *Polymer Engineering Department, Suranaree University of Technology, Nakhornratchasima, 30000, Thailand*
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The causes of its melt index (MI) change in high density polyethylene (HDPE) compounded with carbon black (CB) was investigated. Ordinarily, the MI change can occur in many processing applications such as pipe and wire & cable, and the nature of this change depends greatly on the type of degradation of branching, crosslinking, and/or chain scission. The effects of 6 parameters, namely, barrel temperature, screw speed, initial MIs of HDPE formulation, antioxidant types & ratio, and carbon black content, as well as their interactions, were studied via design of experiments (DOE) using a pilot twin screw extruder (TSE). The barrel temperature, screw speed, and antioxidant package were found to significantly affect the MI of the final product. Suggestions are made on how the obtained correlation could be used to predict the MI change in larger extruders.

Keywords: Melt index (MI), HDPE, Carbon black, Compound, Extrusion, Degradation

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The Role of Organoclay on the Flow Behavior and Electrical Properties of Carbon Nanotube/ Polymer Composites

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Wide range of composite compounding methods are currently being investigated to optimize the dispersion and distribution of inherently conductive fillers in polymer matrices for maximum conductivity. Though good dispersion/ distribution of conductive filler help in attaining right levels of homogeneous electrical properties in the compounded composite, this step necessary but not sufficient to attain high conductivities in the final product. This is partly due to added thermo-mechanical histories generated in the subsequent shaping processes including extrusion and injection molding. In particular, the high shear history applied in the injection molding is known to alter and in most cases reduce the conductivity of the final parts dramatically. This paper discusses the effect of introducing organoclay on the flow behavior and the electrical properties of the carbon nanotube (CNT)/ polymer composites produced in injection molding. Polycarbonate (PC)/ CNT and Nylon 66/ CNT composites varying in the organoclay content was prepared by melt blending using twin screw extruder. The organoclay filled PC/ CNT and Nylon 66/ CNT composites were then injection molded under a range of injection molding conditions to study their morphology as well as electrical properties. The effects of organoclay and their loading on the flow behavior of the PC/ CNT and Nylon 66/ CNT composites were followed by measuring the viscosity of the melt polymers at different shear rates whereas the electrical properties were investigated by measuring the surface resistance (SR) of the injection molded plaques. The morphology of organoclay in PC/ CNT and Nylon 66/ CNT molded plaques were characterized using Transmission Electron Microscope (TEM) and X-Ray Diffraction (XRD). Results obtained on electrical conductivity in molded parts of CNT and Clay filled PC and Nylon 66 have shown that organoclay is able to control dispersion of the CNT during injection molding and preserve the conductivity of the molded parts.

Keywords: Organoclay, flow behavior, electrical properties.

[Open full paper]

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Transparent grade ABS- an alternative to other existing similar grade of transparent or translucent plastics material.

Yee Kok Leong

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Toray, a well known ABS resin (thermoplastics) manufacturer, always strives to develop new grades of ABS resin by optimizing respective features of A (Acrylonitrile), B (Butadiene) and S (Styrene) yet maintaining good properties balances in its characteristic. **"TOYOLAC"** – The brand name is widely used in automotive, electrical and electronics appliances, OA machines, house hold, commodity products and other applications. In this presentation, we will focus on **Transparent Grade ABS**, which is widely used and applied in various sectors. As one of the main player in the plastics resin industry, especially ABS resin business, Toray has ventured into transparent ABS development more than 40 years ago, starting off with extensive involvement in development, followed by manufacturing and sales of this grade. To date, not only as biggest producer and supplier of Transparent ABS, the brand "Toyolac" ABS also known world wide, with its supremacy in products quality and cost effective application advantages that offer good alternatives to existing similar transparent grade of plastics material (PC, PMMA, PS, MBS, PET-G). Research and development is still on going to further innovate and transform this material into specialty and advance grade for more advance usage.

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PROCESSING OF RUBBER TOUGHENED EPOXY NANOCOMPOSITE

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Epoxy resins are very important thermosetting polymers used as a matrix phase for high performance composites. It has been widely used in various fields ranges from electronics, aerospace, powder coating, laminates structural composites and adhesives. As a thermoset resins, the cross linking character of cured epoxies produces a highly undesirable property: they are relatively brittle, having poor resistance to crack initiation and growth. In order to improve the impact toughness of the epoxy resins, being the subject of intense investigations throughout the world for many years, incorporation of rubber filler as a distinct phase of microscopic particles is proved to be a success. Rubber-toughened epoxy nanocomposites is rather a new breed of idea in enhancing the physical properties of the epoxy composites system, whereas this ternary system is designed to obtain a high impact toughness while retaining its excellent strength and elastic modulus resulted from nanoclay reinforcement. In this research , we have worked on a similar ternary system of epoxy nanocomposite, using liquid epoxidised natural rubber (LENR) and MMT-type nanoclay as filler, to investigate the most suitable processing method . Extrusion method was chosen due its capability to provide a continuous output while providing an adequate shear mixing for all the components throughout the process. The set of processing temperature are based on DSC analysis on the neat epoxy, these temperature must be high enough to provide the melt flow of epoxy resins in the twin-screw barrel while avoiding the onset temperature of the curing reaction. Post curing at higher temperature than the curing stage, right after the hot-press (stages where curing and shaping taking place), are pivotal for the system to complete its cross-linking process. The result from sample characterizations has shown an encouraging performance on the system. The SEM and TEM micrographs has shown the phase separation of rubber and nanoclay which are fairly well distributed in the matrix phase. The impact toughness and fracture toughness of the composites is improved while maintaining its strength in mechanical properties. On the other hand, thermal properties of the system were greatly influenced by the present of the low-T_g natural rubber; the T_g and T_d of the system are slightly lower than neat epoxy .

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SIMULATIONS OF PELLETIZE, FLAT DIE AND FILM CASTING WITH RHEOLOGICAL PROPERTIES.

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Flow simulations of extrusion film forming process and pelletization such as flat die, multi manifold die and film casting were performed using finite element software POLYFLOW (ANSYS INC.). Rheological properties are appropriately taking into account for simulation model. Effects of Rheological properties on flat die flow and film casting are investigated.

Keywords: Flow simulations, Rheological properties, Flat die, Multi manifold die, Film casting, Pelletization,

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Study on bi-axially stretched co-polyester film that has uniaxially heat shrinkage property

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Heat shrinkable film made of stretched film is widely used for decorative label by attaching on the PET bottle with heat shrinkage by steam or dry heating. Trouble cancellation in the installation process of the PET bottle is necessary. The purpose of this study is development of uniaxially heat shrinkable co-polyester film that has strength both in machine direction (MD) and transverse direction (TD). The film production was performed using sequential biaxial stretched process that combined roll stretching with TD stretching. Cast film was processed in order of TD stretching – Anneal 1 – MD stretching – Anneal 2. As a result, the heat shrinkable film that shrunk only in MD got high tensile strength both in MD and TD. The anneal 1 temperature over Tg (Glass transition temperature) of material resin was needed to obtain the heat shrinkable film shrunk in MD after TD stretching.

Key words: shrinkable film, Shrinkage property, Biaxial stretching, Anneal

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Measurement of Diffusion Coefficient of Acetone in Cellulose Acetate for a Dry Spinning Process

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Diffusion of acetone in the dry spinning of cellulose acetate-acetone system shows a complicated behavior. The diffusion coefficient of acetone in the dope of cellulose acetate-acetone system varies with the concentration of acetone and the temperature of dope. The concentration of acetone and the temperature of dope change during dry spinning. In order to simulate the dry spinning process of cellulose acetate, the diffusion coefficients have been measured under various concentrations of acetone in dope and various temperatures of dope.

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New Pharmaceutical Packaging Trend and kp High Barrier Films Innovation

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Driven not only by the increased human population worldwide but long lifespan expectation, pharmaceutical industry continuously innovates new drugs to accommodate this trend. Pharmaceutical packaging in blister packs can protect perfectly each individual tablet or capsule and are considered as the best packaging for pharmaceuticals in terms of safety, traceability, hygiene and product life. High barrier for moisture and oxygen, compliance with regulations and run smoothly and efficiently on speedy blister machine are major challenges for this industry. Klöckner Pentaplast as the world leading manufacturer of rigid films for pharmaceutical blister packaging has addressed challenges of new pharmaceutical packaging trend of barrier, cost, productivity and speed to market by manufacturing the industry's most extensive range of pharmaceutical packaging films, from mono films to high-performance barrier-enhanced films and laminates by including multilayer material such as PCTFE -Polychlorotrifluoro ethylene-(ACLAR®), COC, PVdC to offer the highest moisture and oxygen barrier properties available in the world today. The innovation of new surface texture lowers the coefficient-of-friction to significantly improve the film's slip properties leading to higher line and machine throughput yields. The three-layer symmetrical structure (PVC/ACLAR®/PVC) films improve lay-flat of finished packages, increasing productivity in blister packing operations, on both packaging lines and end-use applications. Lastly, BlisterPro™ software: this computer simulation program introduces finite element analysis for blister pack thermoforming. The program provides thickness distribution, surface area, and permeability estimates of thermoformed cavities. These calculations allow package engineers to design optimal blisters around product shapes and barrier requirements.

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Conductive Polymers Containing Hybrid Carbon Nanotubes, Carbon Black and Graphite Nanoplatelets

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Nanocomposites reinforced with hybrid fillers of carbon nanotube (CNT), carbon black (CB) and graphite nanoplatelets (GNP) were developed for electronic applications as the electric conducting adhesives and thermal interface materials. Special focus was placed on enhancing the electrical conductivity of the composites with balanced mechanical properties while lowering the cost of the final product. Epoxy-based nanocomposites were successfully prepared with varying combinations of CNT and CB, or CNT and GNP as the hybrid conductive fillers and their electrical and mechanical properties were evaluated.It was shown that adding CB in CNT-epoxy nanocomposites can enhance the electrical conductivity: a low percolation threshold was achieved with 0.20 wt% CNT and 0.20 wt% of CB. CB enhanced the ductility of the nanocomposites, confirming the synergic effect of CB as effective multi-functional filler. There was a significant increase in impact fracture toughness due to the incorporation of carbon black, whereas the flexural modulus and strength remained more or less the same as the nanocomposites made from CNT alone. The hybrid nanocomposites containing optimal contents of 1 wt% CNT and 1 wt% GNP achieved the highest electrical conductivity of 4.7×10^{-3} S/cm when the total reinforcement contents were fixed at 2wt%. This conductivity was more than two orders of magnitude higher than that of the nanocomposites with 2wt% GNP alone. Although the flexural properties were only marginally changed by hybridization, the quasi-static fracture toughness was enhanced significantly by increasing the CNT contents. Other synergic effects arising from the hybridization are discussed.

Keywords: Conducting polymers; Electrical conductivity; Carbon nanotube; Carbon black; Graphite nanoplatelets

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Stereocomplex Formation of Poly(L-lactide) and Poly(D-lactide) via Electrospinning

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In the present study, poly (L-lactide) (PLLA)/poly(D-lactide) (PDLA) blended solutions were electrospun into nanofibers using a rotating disc collector. Different rotational speed of the disc collector, i.e. different take-up velocities, were utilized in order to investigate effect of the electrospinning condition on stereocomplex formation in nanofibers. The stability of the stereocomplex structure was studied in annealing, plasma and e-beam irradiation.

Keynotes:

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Toughening of Polypropylene by elastomeric nano-particles.

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Generally, toughness of polypropylene (PP) is an issue which has been investigated for many years . The ductility and toughness of these materials are explained in light of the competition between crack formation and the degree of plastic deformation through crazing and shear yielding. The second phase morphology with smaller average rubber particle diameter D appears to be more efficient than that with larger D in toughening PP. We improved toughness of PP by blending PP with a elastomeric nano-particles. Scanning electron microscopy showed a small amount of elastomeric nano-particles was found dispersed particle in PP matrix. The mechanical properties of PP were measured using a tensile test. The results show the average values of tensile strength and toughness were increased.

Keywords: toughness ,dispersed particle,elastomeric, nano-particles

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Electrospinning Technique and View to the Mass Production of Nanofiber

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The creation of the nanofiber that used the electro-spinning process and the examination to the mass production were done. In addition, we examined the possibility of the melt-spinning method of the nanofiber for PP and PE polymer. It has been understood that productivity is low though the nozzle method of the electro-spinning can obtain a stable nanofiber nonwoven.

Key words: Nanofiber, Electrospinning, Multi nozzle, Polypropylene

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Hollow TiO_2 Microstructures Templated by Electrospun Droplets of Polymer Aqueous Solutions

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A new and simple method of fabricating TiO_2 hollow microstructures was developed based on electrospinning and sol-gel reaction. A viscous aqueous solution of polyethylene oxide (PEO) was electrospun or electrosprayed and the produced droplets of the PEO solution were introduced into a titanium tetraisopropoxide (TTIP)-hexane solution. The hydrolysis reaction of TTIP induced at the interface between polymer aqueous solution and TTIP solution led the formation of hollow TiO_2 microstructures reflecting the morphologies of droplets. The possibility of controlling the morphology resultant TiO_2 by the preparation conditions, such as the molecular weight and the concentration of polymer solution, and the voltage and needle-to-ground distance during the electrospinning process was studied.

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Mechanical Properties of Nano-matrix structured Material

Seiichi Kawahara, Keiichi Akabori and Yoshimasa Yamamoto

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Preparation of a model natural rubber dispersed in nano-matrix was made by graft-copolymerization of deproteinized natural rubber latex with styrene, using *tert*-butyl hydroperoxide / tetraethylenepentamine as an initiator. The products were characterized by ^{1}H-NMR spectroscopy and size-exclusion-chromatography after ozonolysis. The grafting efficiency of styrene was more than 90% under the best condition of the graft-copolymerization. The morphology of the film specimens, prepared from graft-copolymers, was observed by transmission electron microscopy after staining the films with OsO_4. Natural rubber particle of about 0.5□m in diameter was dispersed in polystyrene matrix of less than 15 nm in thickness.

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Recent Progress Of In-Mold Visualization Technologies For Fine Pattern Replication Process In Injection Molding

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In order to clarify the transcription process of micro-patterns, direct visualization of the filling behavior of melt into microstructures (micro surface shapes) is required. Given the growing needs for sophisticated visualization technologies with very high magnification rate and resolution within several 10 ms for this direct visualization, the authors have been carrying out visualization analyses of the micro-pattern transcription process by injection molding in recent years using a visualization mold inserted with a quartz prism glass we developed in 1986. Our development efforts in this area started with the (1) development of an indirect visualization technique for identifying filling depth from the reflected light of prism patterns, which we then expanded to the (2) development of direct visualization in the direction of the parting face using a camera installed outside the mold and (3) direct visualization from the side of the mold, and (4) development of direct visualization using a built-in microscope. Currently, we have succeeded in visualization at high magnification rates above x360 as a result of (4). This report introduces the latest visualization techniques and some of our analytical studies on interesting transcription molding henomena.

Keywords: Visualization, Fine pattern, High-magnification, Flow behavior

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High-Magnification Visualization of Melt Filling Behaviors in Fine-Pattern Replication Molding using New Microscope-Installed Mold

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This study aims to clarify resin filling behavior in the cavity through filling behavior visualization experiments targeting micro rib and step change portions of several 10 to several 100 μm in size. This report clarifies melt filling behavior into fine patterns and the generation process of weldlines generated at the downstream side of micro convex patterns using a microscope-installed mold developed for this purpose. Visualization of melt filling behavior at various convex-shaped pattern areas of different sizes was carried out, and the effects of the difference in pattern sizes on filling behavior were clarified.

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New functions of Thermoplastic Elastomer based Sandwich Injection Moldings

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Damping materials such as thermoplastic elastomer (TPE) usually has very low stiffness and easily deformable, hence they are unsuitable for structural applications. This paper focuses on using sandwich injection molding technology to produce parts consisting PP skin and TPE core to impart high surface rigidity while maintaining dampening efficiency. Correlation between skin-core adhesion and flexural and damping properties of the moldings are discussed. Sandwich injection molding system is generally used for imparting soft feel or good grip characteristics on the outer surface while maintaining a rigid core in the moldings. Recycled material has also been used as the core material. Recently, TPE has new functions, i.e. high melt flow rate, toughness, damping effect etc. Therefore, in this study, the soft TPE was injected as the core instead while a more rigid material forms the skin. The relationship between vibration and impact performance of sandwich moldings with TPE core was established.

Keyword: Injection ; Sandwich ; Elastomer; Vibration, Impact

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EVALUATION OF MOLECULAR ORIENTATION IN INJECTION-MOLDED POLYPROPYLENE

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Molecular orientation in injection-molded polypropylene (PP) was evaluated by polarized laser-Raman spectroscopy. The main purpose of this study was to clarify the differences in molecular orientation between general purpose PP (GPPP) and high stiffness PP (HSPP) which was modified by small amount of a crystal nucleating agent. The intensity ratio of two intrinsic peaks in a Raman spectrum was considered to be a molecular orientation index. In GPPP, orientation was observed only in the skin layer beneath the surface. The thickness of the layer decreased with an increase of injection speed. As for HSPP, some pairs of highly oriented layers parallel to the flow direction were found even in the inside of the specimen. Moreover, molecular orientation of the weldline region of these two kinds of PP was also studied. Whereas there was no orientation along the weldline interface of GPPP, strong orientation was found in that of HSPP. GPPP with weldline elongated as well as that without weldline in tensile test. In contrast, HSPP with weldline showed breakage in a brittle manner. This suggests that the orientation degree in PP has much influence on their mechanical properties.

Keywords: Raman spectroscopy/ Polypropylene/ Molecular orientation/ Mechanical properties

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Development a Plastic Waste from Soft Drink Bottle Polyethylene terephthalate for Textile Fiber Application

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In this research, the effect of chain extension on mechanical properties of blending of recycled polyethylene terephthalate (RPET) from waste bottles with polypropylene (PP) in the presence of compatibilizer was studied. The idea of blending RPET with PP was the recycling PET bottles together with their PP-based caps in same time. Blending of RPET with PP (RPET/PP) was prepared in the presence of 0-7 phr of compatilizer. Morphological analyses suggest that the size of dispersed PP phase was dependent upon both the PP content and amount of compatibilizer. The addition of compatibilizer up to 3 phr resulted in a 10 fold size reduction of the dispersed phase and more homogeneous particle distribution was obtained. The compatibilizers appear to have a tendency for migrating towards the interfacial regions between RPET and PP phase. The morphological developments in compatibized blends significantly affected their tensile and impact resistance. Moreover, the addition of chain extension 0-1.5 phr into RPET/PP together with compatibilizer 3 phr was prepared. Resulting RPET/PP compounds were extruded as a monofilament fiber. The flexural modulus and the flexural strength of the PET/PP fiber with and without chain extension were observed.
Keywords: Recycling PET, Polymer Blending, Chain extension, PET Fiber

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Comparison of 2.5D and 3D Injection Molding Simulation of Flat Plates with Non-Uniform Part Thickness

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The experimental study and numerical simulation of the melt front advancement, course of the pressure and melt temperature profile during the injection molding of flat plates with non-uniform part thickness were carried out using the simulation program Moldex3D®. The molded part composes of two thin plates joined together with a cold runner. One fan gate is connected to the thick side (4.5 mm) of the first plate and the other connected to the thin side (2 mm) of the second plate. 2.5D simulations based on the generalized Hele-Shaw model were done with two different surface mesh types and by varying the number of mesh layers that can be freely defined during the simulation parameter setting. 3D simulations, in the same way, were conducted with three different volume mesh types and by varying the number of element layer counts over the part thickness. Comparisons between the experiment and simulation performed with the same molding parameters were carried out. From the results, the number of mesh layer over the part thickness has little to no effect on the accuracy of the simulation results in terms of predicting the melt front advancement in the cavity. On the other hand, noticeable deviation in the temperature distribution between the mesh types and the number of mesh layers can be acquired. Astonishingly, 2.5D simulation was verified to be more reliable than 3D simulation particularly in terms of predicting the melt front advancement as well as the melt pressure development during the molding. Owing to the complex flow and unbalance of the pressure within two cavities of the part, 3D simulation based on non-isothermal computation failed to predict course of the pressure and hence the melt front advancement within both cavities. However, with the 3D isothermal computation, improvement in accuracy was achieved. By molding the double-plated part separately, both 2.5D and 3D simulation results agreed well with those from the experiments.

Keywords: Injection Molding, Simulation, Comparison, Non-Uniform Part Thickness

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Simulation and Optimization of Plastic Injection Molding

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Some selected research activities in simulation and optimization of plastic injection molding at the Singapore-MIT Alliance Manufacturing Systems and Technology Programme and the School of Mechanical and Aerospace Engineering, Nanyang Technological University are introduced. Warpage of parts is reduced by cavity balancing with the utilization of the flow path concept. Optimization of gate and weld line locations can be achieved by the application of the same concept. Through simulations, it is shown that the determination of the optimum injection time by the widely adopted Scientific Molding concept is no more than the minimization of injection pressure, which can be easily implemented. Limitations of existing simulations for cavity with thickness and features much less than a mm are discussed. A surface roughness model resolving these limitations is proposed, with experimental verifications.

Keywords: Cavity balancing, Gate location optimization, Weld line optimization, Scientific molding, Micro-injection molding.

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Orientation Birefringence of Cellulose Ester

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Orientation birefringence and its dispersion over a wide range of wavelength for cellulose acetate propionate (CAP) and cellulose acetate butyrate (CAB) thin films produced by compression molding techniques are studied. Both CAP and CAB show a positive orientation birefringence that increases with the wavelength. This extraordinary wavelength dispersion of CAP and CAB is attributed to the difference in polarizability anisotropy of ester groups.

Keywords: Birefringence, Cellulose Ester, Wavelength Dispersion.

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Influence of morphology on uniaxial tensile behavior of polyoxymethylene

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Polyoxymethylene (POM) has been widely used as an engineering plastic with high rigidity and high crystallizability, but there is not much information about its morphology and its influence on uniaxial tensile behavior. In this study, the influence of crystallinity on the uniaxial tensile properties were examined using POM copolymers having various degrees of crystallinity. It was found that as the crystallinity increases, the toughness decreases, and drops sharply between the crystallinity 60% and 62%. The materials having the crystallinity above 62% becomes brittle. The morphological observation by the scanning electron microscope showed that the spherulites of the brittle samples are bigger compared to the ductile samples.

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EVALUATION OF LONG-TERM PERFORMANCE OF PLASTIC PIPES FOR HOT WATER SUPPLY

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Plastic pipes such as PEX and PB pipes have been widely used for water and hot water supply, and for central heating for residential use in Japan. The qualities of PEX and PB pipes and joints have been maintained at high levels as products and as jointing techniques for 20 years or more in Japan. There are few leakages and failures in actual use. The PEX and PB pipe systems have been evaluated for their high quality. The polyethylene for raised temperature (PERT) pipes has recently been introduced also for central heating and floor heating for residential use as they have a possibility to reduce the pipe cost.There are three modes of failure for plastic pipes, which are ductile failure(I), brittle failure(II), and chemical degradation failure(III) as well known. The amount of remaining antioxidants gradually decreases with time. To prevent brittle failure and chemical degradation failure and to obtain a high stress rupture strength, a high molecular weight resin should be selected for plastic pipes. To delay the occurrence of chemical degradation failure, it is important for antioxidants to be integrated, considering thermal stability and minimizing degradations and to be sufficiently added in a polymer. To maintain long-term resistance of plastic pipes to thermal and chemical degradations due to hot water and residual chlorine at elevated temperature for hot water supply and also for central heating and floor heating, suitable antioxidants are added in general. The Oxidation Induction Time (OIT) test is also a useful test to evaluate relative thermal stability. A value of 100 minutes or more by OIT is required for thermal stability at 210 degrees C in an oxygen atmosphere.The long-term strength of plastic pipes can generally be evaluated by the stress rupture test. A 30-years-or-more service life of the system for central heating should be guaranteed at 90 degrees C under an inner pressure of 0.25 MPa. No failure at 12,000 hrs or more should occur at 110 degrees C by the accelerated stress rupture test specified in ISO1167. The full-notch tensile creep test at elevated temperature is also useful to evaluate long-term strength as an accelerated test method.

Keywords : PERT, failure, long-term strength, chemical degradation, hot water supply

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Applications of High-Frequency Induction Heating to High-Quality Injection Molding

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High-frequency induction heating is an efficient way to rapidly heat mold surface by utilizing a high-frequency skin effect. Because the procedure allows for the rapid heating and cooling of mold surfaces, it has been recently applied to the injection molding in various purposes. The present work introduces various industrial applications of high-frequency induction heating to high-quality injection molding including: (i) moldability improvement in thin-wall injection molding, (ii) improvement of replication ratio of micro-features, and (iii) remove of weldlines for a mobile phone cover which contains multiple holes.

Keywords : Injection Molding, High-Frequency Induction Heating, Thin Wall Molding, Micromolding, Weldline.

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VISUAL ANALYSIS OF GATE FLOW PHENOMENON IN HIGH SPEED INJECTION PROCESS

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This study investigates the phenomena of Polypropylene (PP) and Thermoplastic Elastomer (TPE) melt flow in the filling stage of the high speed injection molding process. A flow visualization mold was specially designed and made for this study. A high speed video camera (HSVC) was used to record the mold filling phenomena of rectangular cavities with various gate geometries. Experiments were carried out on a 180-ton injection molding machine and the injection speed was varied up to a maximum of 1000 mm/s. Significant variation of polymer melt flow which increases with increased injection speed was observed in the filling stage at the gate portion. It has been found that the flow pattern is very dependent on injection speed and gate geometries. The jetting phenomenon occurred and melt flow is more concentrated around the gate area than away from the gate. The associated changes in topography of the fillings have been studied using HSVC. These prominent behaviors are unexpected for conventional injection molding process.

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Multiple Optimum Design for Injection Molding Die by Nonlinear Approximation Technique

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The injection molds consume costs and time for manufacture. Therefore, it is important to predict the molding method. So, The CAE technology that injection molds design using the resin flow analysis. This method is possible for checking the validity of a design. So, this technology cannot make the indication or the automatic correction of a point that improve design variables, such as the runner diameter, and the amount of resin, when fault arises in initial setting. Therefore, a design change is fixed by the trial and error of the engineer. In this research, improvement of a genetic algorithm (GA) is advanced so that the multi-cavity molding of an injection molding can be automatically determined using the GA, which is one of the discrete optimization method.

Keywords: Injection molding die, Optimum Design, Finite Element Method, Genetic Algorithym

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Measurement of Melt Temperature Distributions in Y-shaped Runner Split Zone Using New Measuring Mold with Round Rotary Block Structure

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The authors have designed and built a new measuring block with round rotary structure incorporating several infrared radiation temperature sensors for measuring resin temperature distributions of melt resin inside the cavity and runner during the injection molding process. This measuring block is installed in the stationary mold, and sensor positions are changed by rotating or horizontally moving it while controlling its angle and position, to order to measure resin temperature at any point. This enables measurement of temperature at high resolutions along the width, length, and curve of cavities and runners with angles, which has been difficult until now. Using this measuring block, the temperature distribution in the Y-shaped runner split zone was measured. Based on the changes with time in the temperature distribution along the orthogonal direction of runners and the resin filling behavior in the cavity and runner observed in visualization experiments, correlative analysis between the runner balance and runner resin temperature in the Y-shaped runner was carried out.

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Structure and rheological properties for binary blends of polypropylene and surface-modified PTFE

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Rheological properties for binary blends composed of isotactic polypropylene (PP) and acrylic–modified polytetrafluoroethylene (PTFE) are studied. It is found that blending a small amount of PTFE greatly enhances the storage modulus in the low frequency region. Further, drawdown force and normal stress difference increase with the PTFE content. Electron microscope observation reveals that PTFE deforms into fine fibers whose diameter is smaller than 1μm. The interdigitation among the fibers are responsible for the marked elastic properties.

Keywords: Polymer Blend, Polypropylene, Polytetrafluoroethylene, Melt Elasticity, Rheology

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RHEOLOGY OF HETEROGENEOUS POLYMER MELTS

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Polymer blend and alloys are some of the most important thermoplastic engineering plastic on the market. Since they are rheologically complex materials, their melt rheology must be treated differently than homogeneous, single phase plastics. A study was carried out to characterize the melt rheology of two commercial injection molding grades of ABS resins. One is a neat resin and the other contains 10 percent glass added to the neat resin. Measurements were carried out with a Rosand capillary rheometer and a Gemini rotational rheometer, both manufactured by Malvern Instruments. These instruments are utilized in industry to relate a plastic's performance to both their structure and processing behavior. The rotational rheometer is most suitable for analyzing the structure of these plastics, and the capillary rheometer is most useful for relating the rheology to their processing behavior.

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Plasticizing Effect and Electrospinability of Chitosan Derivatives/PVA

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Chitin is the second most found polysaccharide in nature after cellulose. However, due to its poor solubility and reactivity, it has limited applications. Unlike chitin, chitosan has been extensively used in both industrial and medical fields. High molecular weight chitosan can dissolve only in acidic condition. Converting chitosan to chito-oligosaccharides and quaternised chitosan has attracted more attention because they are not only water-soluble but also have versatile biological properties such as antimicrobial and antitumor activities. Electrospinning is one of popular techniques producing polymer nanofibers with distinguished property. Unfortunately, it has been reported that chitosan could not electrospun by itself. Many blends of potential polymers with chitosan have therefore been investigated. One of those is poly(vinyl alcohol) (PVA). PVA is highly hydrophilic and able to easily form fibers, films and crosslink fiber mats. In this work, high molecular weight chitosan was modified to COS (Chito-oligosaccharide) and *N*HTCC (*N*-(2-hydroxy)propyl-3-trimethylammonium chitosan chloride) to increase solubility in water. The spinning solution was prepared from polymer blend, COS/PVA and *N*HTCC/PVA at various ratios (100/0, 85/15, 75/25, 50/50, 25/75, 15/85 and 0/100) and at solution concentrations of 20% (wt/vol). PVA used in this study is soluble in cold water with molecular weight of 30,000-70,000 Da. The spinning solution viscosity, conductivity and spinability were investigated. The results showed that blending high molecular weight chitosan derivatives with PVA can reduce solution viscosity and hence increase more chance of spinability. While blending low molecular weight chitosan derivatives with PVA causes solution viscosity lower than that of pure PVA solution due to plasticizing effect. This plasticizing effect can affect the spinability of the blend.

Keywords: Chitosan, Electrospinning, Nanofiber, Poly(vinyl alcohol)

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Rheological Behavior and Structure of Multi-component Polymer Systems

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Rheological behavior of multi-component polymer systems was discussed in terms of the structural change by the composition and physical stimuli. One typical example is poly(vinyl chloride) / plasticizer system. PVC forms physical gels in various solvents. We found that the storage and loss moduli, *G'* and *G"*, of PVC/plasticizer with high polymer concentration showed the power-law dependence on the angular frequency at a critical temperature. At the same time, tan δ was independent function of the frequency at the temperature which is referred to as the critical gel temperature. The critical relaxation exponent was 0.75 regardless of polymer concentration. This result well accorded with the value reported previously for low PVC concentration systems. These results suggest that the PVC gels have a similar fractal structure irrespective of type of plasticizer and the content. Another is poly(styrene-b-(ethylene-co-butylene)-b-styrene) (SEBS) triblock copolymer / hydrocarbon oil system. SEBS exhibited very long relaxation time mode and its weak temperature dependence, since even at the highest temperature conducted the neat block copolymer stayed microphase separated. *G'* of SEBS/oil blends drastically decreased with increasing temperature up to a critical temperature, which can be assigned to be order-disorder transition (ODT). An *in situ* observation of morphological change of SEBS induced by temperature and phase transition was conducted by atomic force microscopy. The heterogeneous domain structure remains just below the critical temperature but disappeared completely above the temperature. It was confirmed that this is consistent with the rheological behavior which is very sensitive to variation of temperature in the vicinity of ODT temperature. Rheological behavior of SiO_2/(AP/EP) suspension with various SiO_2 volume fractions (ϕ) in a blend of acrylic polymer (AP) and epoxy (EP) were investigated at various temperatures. This complicated system showed sol-gel transition type rheological behavior, characterized with power-law relationship when increasing SiO_2 concentration.

Keywords: Rheology, Sol-gel transition, PVC, SEBS, Suspension.

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Rheological of Natural Rubber Blends: Compatibilization, Co-continuity prediction and Phase inversion detection

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Shear and elongation flow properties of natural rubber blended with various types of thermoplastic such as polypropylene, polyethylene, EVA and PMMA were investigated. It was found those flow properties could be used to determine compatibilization between the blending pairs with or without blend compatibilizer. Log-additive rule has been typically used to estimate the blend compatibilization. This causes smaller or finer blend morphology and enhancement of mechanical and strength properties of the blends. Co-continuity and phase inversion of the NR blends could be detected based on calculation using viscosity data of the blend components and processing conditions via various empirical models. These include Paul and Barlow, Utracki, Metelkin and Blekht, Steinmann, and Gergen models. The prediction was correlated to the experimental results based on NR/HDPE and NR/EVA blends. It was found that some models could predict the co-continuity and phase inversion phenomenon of the natural rubber blends.

Keywords: natural rubber, copatibilization, co-continuity, phase inversion, thermoplastic

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Radiation Processing of Natural Rubber

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Radiation technology has emerged as one of the foremost techniques for processing of polymeric materials and it has been an area of enormous interest in the last few decades. Radiation processing involves mainly the use of either electron beam (EB) from an electron accelerator, gamma irradiation from Cobalt-60 (Co-60) sources or ultra-violet (UV) irradiation from mercury or xenon arc to beneficially alter the properties materials such as polymers, fibers, fabrics, semiconductors and gemstones. Irradiation can induce reactions in polymers, which may lead to polymerization, crosslinking, degradation and/or grafting. Cross-linking is a reaction where polymer chains are joined and a network is formed. Natural rubber (NR) can be cross-linked by irradiation. This paper outlines the radiation crosslinking of NR, with emphasis on dry rubber, Epoxidized natural rubber (ENR), NR latex and NR based blends. The general effect of radiation on polymers, classification of some irradiated polymers, reactions of polyfuctional polymers (PFM) with free radicals as well as the role of water and radiation sensitizer in the radiation vulcanization of natural rubber latex is also briefly discussed.

Key words: Irradiation; Crosslinking; Natural Rubber; Properties; Reactions

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Thermal Properties of Side-chain Crystalline Acrylic Polymer

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Thermal properties of a side-chain crystalline acrylic copolymer, consisting of octadecyl acrylate (35 wt%), methyl acrylate (60 wt%), and acrylic acid (5 wt%), crosslinked by aluminum (0.5, 1.0, and 2.0 wt%) were investigated by differential scanning calorimetry (DSC), thermal mechanical analysis (TMA), and dynamic viscoelastic analysis. The copolymers show five thermal transitions around 5, 23, 80, 130 and 180 ºC, respectively. The transitions at 5 and 23 ºC observed in all the measurements are assignable to a glass transition and melting of the side-chain crystalline unit, respectively. The transition around 80 ºC observed in the TMA measurement would be due to a significant motion of the main chain. The transition around 130 ºC observed in the viscoelastic analysis might be due to an exchange of aluminum ligands between the acrylic acid units. The transition around 180 ºC observed in the TMA measurement comes from decomposition of the aluminum crosslinks.

Keywords: Side-chain crystalline polymer, Acrylic polymer, DSC, TMA, Dynamic viscoelastic analysis

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Application of Nanoindentation Method to Different Materials and Relevant Affecting Parameters

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Since its invention, Nanoindentaion method has been widely used in characterizing the mechanical behavior of small size samples such as thin film, multilayer materials and multiphase materials etc. The obtained mechanical properties include the elastic modulus, hardness, plastic yielding and failure. However, as the measurements are made on a small area of the sample surface and under micro or nano Newton force, the precision of force and displacement is very important. Even though the manufacturer of nanoindentation apparatus has made the measurement precision be enough high, the relevant affecting factors on the results measured exist inevitably during the testing process. They are indenter geometry, load level and penetration depth. Therefore, in order to investigate the role of those factors, five types of materials including epoxy, SiO_2/epoxy nanocomposites, low temperature co-fired ceramics (LTCC), GaN film and woods are used as target materials and the mechanical behavior are studied by using the Triboindenter. The effect of indenter geometry, load level and penetration depth, as well as the microstructural characters of studied materials are analyzed.

Keywords: Nanoindentation, Solid materials, Mechanical properties

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Factors Affecting Weldline Strength of Polystyrene in Injection Moulding Process

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Weldlines are visual and structural defects that usually occur when two melt fronts meet during injection moulding of plastics. The influences of various materials and injection moulding process parameters on the weldline strength of polystyrene (PS) were examined. Two grades of PS with different molecular weight were used. The parameters that govern the injection process are melt temperature, mould temperature, injection rate and packing pressure. Three types of dogbone specimens were moulded representing no weldline, melt/melt weldline and solid/melt weldline. Standard tensile tests were conducted on moulded parts to measure the resulting weldline strength. The presence of a weldline showed strength reductions with increasing molecular weight. For the effects of injection moulding parameters, the melt temperature and mould temperature were found to have influential effects on weldline strength whereas the injection rate and packing pressure showed only small effects. A higher melt and mould temperature increased the strength of weldline. The effect of low interface temperature during moulding resulted in the lower weldline strength of solid/melt weldline than that of melt/melt weldline. The theoretical weldline strength models, as governed by the degree of healing (diffusion distance of polymer chain across the interface) and the sensitivity of the material to stress concentration (the presence of V-notch) were proposed. The various moulding parameters of melt/melt weldline were also measured to verify the validity of the model.

Keywords: Weldline/Overmould/Diffusion/Cooling Profile/V-Notch

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Preparation and Characterization of Linear Low Density Polyethylene Toughened Polylactic Acid.

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Melt blending of polylactic acid (PLA) and linear low density polyethylene (LLDPE) was performed to investigate the effects of LLDPE as an impact modifier on mechanical and thermal properties of PLA/LLDPE blends. LLDPE wasblended with PLA from 5-15 wt% and prepared by counter-rotating twin-screw extruderfollowed by injection molding into test samples. The mechanical properties of the blends were assessed through tensile, flexural and impact testings while thermal properties wereanalyzed using differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Scanning electron microscope (SEM) was used to study the dispersion and particle size of LLDPE in PLA matrix. The impact strength of PLA improved by 53% with addition of 10 wt% LLDPE. However, the tensile modulus and strength, and elongation at break of PLA/LLDPE blends decreased with increasing weight ratio of LLDPE. Similarly, flexural modulus and strength also dropped with addition of LLDPE. DSC results showed that glass transition temperature (Tg) and crystallinity (Xc) of PLA increased with blending of LLDPE. The LLDPE particles size was seen to increase with increasing loadings of LLDPE which explains the unexpected decrease of impact strength after 10 wt%.

Key words: polylactic acid; linear low density polyethylene; blends

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Alpha-chitin Reinforced Tapioca Starch-based Composite Foam

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Alpha-chitin reinforced tapioca starch-based composite foam was prepared using a compression process. The compress condition was set at 180°C for 2 min with 80-110 kgf/cm2 pressure. The effect of alpha-chitin content at 5 to 30 percent of tapioca-starch on morphology and properties of composite foam were studied. The resulting composite foam was an opened cell structure with regular distribution and gave maximum value of mechanical properties. A result of, it could mix compatibility and a good of fiber distribution in starch matrix. Not only this, alpha-chitin was tough material, tear resistance and it could reinforce to starch foam. Consequently, mechanical properties of composite foam increase clearly when alpha-chitin content was increased to 30%. Higher content of alpha-chitin causes higher density of composite foam, and also better in water resistance property. However, tapioca starch-chitin composite foam has a bit lower in water resistance comparing to KU Green. In addition, it was found that the composite foam has slow degradation with alpha-amylase.

Keywords: Composite foam / Tapioca starch / Alpha-chitin / Biodegradable / Mechanical properties

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Mechanical Performance Evaluation of Natural Fiber Reinforced Poly(lactic acid) Textile Insert Moldings

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Poly (lactic acid) (PLA) is one of the most popular biodegradable thermoplastic polyesters known for its high stiffness and strength. However PLA has been known to be a relatively brittle, which significantly narrows its window of application. Furthermore, the cost of PLA is much higher than commodity plastics such as PP and PE, which is also one of the reasons of its limited usage to date. Therefore, in order to improve the toughness and reduce the cost associated with the usage of PLA, recycled jute bags were incorporated as reinforcement for PLA. This paper explains the unique procedures involved in fabricating PLA/jute composites by means of textile insert molding. The jute mats were also immersed in an aqueous solution of shellac, which is a naturally derived resin that is compatible to the surface of jute and therefore can be used as a surface treatment. The effect of surface treatment on the fiber-matrix interfacial strength as well as mechanical performance of the textile insert moldings is evaluated.

***Keyword**:* Poly (lactic acid), textile insert composites, Injection Molding, Natural fiber

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Heat treatment and recyclability of sugarcane bagasse reinforced PVC composites

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PVC and Sugarcane bagasse reinforced PVC composite plates were produced by a compression moulding method followed by heat treatment process. The effects of different thermal histories were examined by measurements of tensile strength and elongation at break. It was observed that the heat treatments affect the elongation at break of neat PVC significantly with less significant effect to the tensile strengths. There was a decrease of elongation at break in annealed samples. On the other hand, various tensile strengths of sugarcane bagasse PVC composites were observed after various heat treatments with less significant effect to the elongations at break. In addition, recycling of the composites may erase the effect of thermal histories. Mechanical properties of all heat treated composites become uniform after recycling process.

Keywords: Heat treatment, recyclability, bagasse, PVC, composite.

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Unsaturated Polyester Resin from Poly(ethylene terephtalate) waste: Effects of liquid natural rubber and glass fiber mats on its properties

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Poly(ethylene terephthalate) (PET) wastes bottle was recycled by glycolysis process using ethylene glycol. The unsaturated polyester resin (UPR) was then prepared by reacting the glycolysed product with maleic anhydride. The blend of UPR based on recycled PET wastes with liquid natural rubber (LNR) was done by varying the amount of LNR from 0 to 7.5 wt %. Mechanical tests such as impact and tensile test have been conducted to the UP-LNR sample in order to determine the optimum LNR composition. The tensile strength and impact energy increased with LNR and optimized at 2.5 wt % LNR which also shows a well dispersion of elastomer particles in the sample morphology compared to the other blends concentrations. The optimum composition of LNR in UP was used in the process of glass-fiber-reinforced plastics. Treated fiber composites with silane coupling agent shows better mechanical properties compared to untreated fiber composites. SEM investigations show that the surface modifications improved the fiber–matrix interaction. Moreover, the dynamic mechanical analysis (DMA) on the composites indicated that treated fibers based composites enhance the storage modulus and reduced tan-□□ value of the composites.

Keywords: *recycled PET; unsaturated polyester resin (UPR); liquid natural rubber (LNR), glass fiber*

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The green composites from coil fiber and poly(lactic acid): Physical and mechanical properties evaluation

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This research studied the potential of renewable material, coil fiber, as a composite with polylactide (PLA) and starch binder to produce green particleboard. The polylactide was used as a binder in stead of binder from formaldehyde. The fiber and polylactide and starch binder composite was prepared using compression molding at ratio between the composite was 9:1, 8:2, 7:3 and 6:4 respectively. The increase of concentration of polylactide binder increased density and tensile strength of composite. The result of water absorption of composite decreased with higher binder content. As a natural material, it was shown that the mechanical performance of coil fiber with polylactide and starch binder composite could be tailored to reproduce the behavior of green composite boards

Keywords: polylactide , green composite board, coil fiber

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Sturucture and mechanical properties for PLA blends having fibrous dispersion

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Structure and mechanical properties are investigated for binary blends composed of poly(lactic acid) PLA and poly(butylene succinate) PBS or poly(4-methylpentene-1) P4MP1, in which fibrous PBS or P4MP1 is dispersed in a PLA matrix. Dynamic mechanical properties in the solid state reveal that the storage modulus of PLA beyond the glass transition temperature is greatly enhanced by the addition of the fibers. Further, the fibers orient to the flow direction during processing, leading to high level of molecularorientation of PLA. As a result, the degree of crystallization increases.

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Structure and Thermal Property of Al2O3 Fiber Filled Composites in Injection Molding

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Micromolding with thin-wall plates of alumina fiber (Al2O3)/liquid crystal polymer (LCP) and poly(butylene terephthalate) (PBT) composites with different Al2O3 component were performed to investigate thermal diffusivity and processability of molded parts. Effects of process parameters on higher-order structure and various properties of molded parts were evaluated. Thermal diffusivity of molded parts increased concomitantly with the increasing Al2O3 component. Especially, thermal diffusivity of PBT composites showed higher values than that of LCP composites. From the observation of internal morphology of molded parts, the fiber of the core area was oriented randomly in spite of fiber orientation along the flow direction inside the skin-surface area.

Keywords: thermal conductivity, Al2O3, PBT, thin-wall injection molding

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Styrene-modified Natural Rubber (SNR) as Modifier/Compatibilizer for Some PP-based and PS-based Blends

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Styrene-modified natural rubber (SNR) was prepared in the laboratory as previously reported in the literature. This highly grafted, high molecular weight natural rubber was evaluated in various PP-based blends via PP/SNR, PP/NR/SNR, and PP/PS/SNR. The effect of SNR in PS-based blend was also investigated. The blends were prepared based on the dynamic vulcanization technique. Based on mechanical properties and morphological observations, some relevant comparisons are made with results reported in the literature, such as polyolefins/NR blends, Santoprene, and HIPS, identifying the role of SNR as compatibilizer/modifier.

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Kenaf-polyester composite cured by ultra-violet (UV) radiation

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Biocomposites, cured by ultra-violet (UV) radiation were produced using kenaf fibres as the reinforcing agent and unsaturated polyester as the matrix. This work focused on the effects of the incorporation of kenaf fibre, montmorillonite (MMT) and glycidyl metharcylate-modified MMT (GMA-MMT) in the unsaturated polyester composite. From the results, the incorporation of kenaf fibres in the form of mat had improved the mechanical properties of the composites. Addition of MMT into the kenaf fibre-polyester system showed an improvement up to 1% MMT after which it decreased. The increase was attributed to better stress distribution in the matrix. However, further increase in the MMT loading had resulted in the decrease in the properties, which was believed to be due to agglomeration. This can be improved by modifying MMT with GMA which had produced composites with higher mechanical properties as compared to those without modification. This were attributed to a combination of effective distribution of MMT in the matrix, availability of effective high aspect ratio MMT and enhanced compatibility between GMA-MMT with the matrix.

Keywords: montmorillonite, kenaf fibre, ultra-violet radiation, polyester

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Thermal and Mechanical Properties of Injection Moulded Short Glass/Short Carbon Hybrid Fibre Reinforced Polyamide 6,6, Composites

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Hybrid fibres were used to modify / tailor made the properties to suit certain application. In this work, hybrids of carbon and glass fibres were employed as reinforcement for polyamide 6,6 matrix. Glass fibre composite and carbon fibre composite were used as received, physical blended and injection moulded. Injection moulding machine, Boy® 55M was used for the moulding of the specimens. A single gated four cavities, two impacts and two tensile test bars mould was used in the moulding. Before testing, specimens were conditioned at dry, 50%RH and wet environments. Specimens were subjected to the TGA, DSC, DMA, tensile and impact testing.TGA scans within the temperature range of 50-200°C shows a gradual weight loss due to evaporation of water for the 50%RH and wet specimens. The contents of water evaporated for the 50%RH and the wet specimens were less than 2% and 4-5% respectively. DSC results indicated that the ΔH_m reduced as the relative proportions of glass fibre decreased suggesting that carbon fibres absorbed more heat during the melting of the composites. DMA scans show that over a temperature range of -100ºC to 200ºC, two transition regions were recorded. The temperatures at the maximum value of tan δ in ß-transition and α-transition were in the range of -66ºC to -64ºC and 66ºC to 69ºC respectively for dry specimens. For 50%RH specimens, the temperatures at the maximum value of tan δßin -transition and α-transition shifted to lower values of -77ºC to -75ºC and 16ºC to 19ºC, respectively. For wet specimens, only the temperature at the maximum value of α-transition was recorded in the range of -16ºC to -12ºC. This indicates that weakening of the matrix phase occurred as moisture content increased. Tensile and impact tests results show that, hybridisation has positive effect on Young's modulus (E) and critical stress intensity factor (G_c) of the composites.

Keywords: Hybrid fibre composites, Injection moulding, Mechanical properties, Thermal properties

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On the Paintability of Injection Molded Recycled PET/Recycled PP Blend filled with $CaCO_3$

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Evaluation of adhesion strength of paint on injection mold recycled PET/recycled PP blend filled with $CaCO_3$ was studied by using surface and interfacial cutting analysis system (SAICAS). The blends of RPET, RPP and $CaCO_3$ were compound by single screw extruder at various content of $CaCO_3$ and using compatibilizer for improve interaction of recycled polymer blends. The blends were injection mold to square plate specimens then paint by using the Japanese lacquer for purpose studies. The SAICAS method can investigate surface adhesion of paint on injection mold blends which shows profile of adhesion strength of painting of the blends at various content of $CaCO_3$. The effect of thermal treatments is also studies. These results can indicates an affect of $CaCO_3$ on painting of the blends and the influence for long term reliability of decorative painting on injection mold RPET/RPP blend products.

Keywords: RPET/RPP blend, $CaCO_3$, Adhesion strength, SAICAS, paint

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Improvement of Mechanical Properties of CNT-Composite with High Aspect ratio CNT

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Carbon nanotubes (CNTs) are expected to be a new functional material because they have outstanding mechanical, electrical and thermal properties, compared with conventional carbon fiber. However recent reports indicate that mechanical properties, such as Young's modulus and tensile strength, of CNT/polymer composite could not be improved as they are expected. One of the reasons seems that commercial CNTs don't have enough length for reinforcement of mechanical properties at the point of rule of mixture. In order to investigate the effect of CNT length on mechanical properties, CNT aligned along the vertical direction was synthesized by rf plasma CVD method to obtain the uniform length CNT. After melt mixing, tensile test specimens of in-house CNT/polymer composite were fabricated by a hot press. As the results of tensile tests, Young's modulus increased by 25% and tensile strength increased by 45% under the condition of 620μm length and 1wt% CNT loaded. It is found the Young's modulus and tensile strength could be improved by using longer CNT.

Keywords: Carbon nano tube, Polymer matrix composites, Vertical growth CNT, Length of CNT, Young's modulus, Tensile strength

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Assessment of Fiber Damage during Processing and its Relation to Mechanical Properties of Natural Fiber Reinforced Plastics

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The aim of the study was to investigate the influence of processing temperature on the extent of fiber damage during processing and its effects on mechanical properties of empty fruit bunch (EFB) – high density polyethylene (HDPE) composites. Fibers of 3-5 mm in length were compounded with HDPE in the ratio of 20:80 to form bio-composites using an extruder. In preparation of the tensile and flexural test bars, the composites were injection moulded at various temperature from 170ºC, 175ºC, 180ºC, 185ºC to 190ºC. Fiber damage characterization was conducted pre and post extrusion, and post injection moulding by dissolving the HDPE matrix from the composites using xylene. The results showed that considerable fiber damage happened during the extrusion process where 56% fibers were shortened due to the effect of the rotating screw during the compounding process. During the injection molding process, a further 3% of fibers were damaged with fiber length less than 3 mm. As the injection molding temperature was increased from 170ºC to 190ºC, the amount of fiber damaged increased steadily from 59% to a maximum 63%. The increased in temperature has weakened the fibers and caused them to break more readily. The study also found that the tensile and flexural strength decreased as the moulding temperature increased. The opposite trend was observed for the tensile and flexural modulus with exceptions at 185ºC and 190ºC. The findings showed that using higher processing temperature increased the likelihood of fiber damage and consequently reduced the tensile and flexural strengths of the composites.

Keywords: Fiber damage, processing, bio-composites, natural fiber reinforced plastics

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LED Encapsulation using Epoxy and Silicone

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Light emitting diodes (LEDs) are energy saving devices being actively promoted world-wide to replace conventional filament and fluorescent lamps for illumination, signaling and displays. Epoxies and silicones have been used to encapsulate LED chips. The race to introduce higher power and ever higher brightness devices to the mass market has created challenges in development of high performance encapsulation materials. Epoxy has great adhesion strength to most electronic substrates. It provides very good chemical and mechanical protection to the LED chips. However there is a tendency for high encapsulation stresses and light degradation from high temperature and strong UV irradiation. Silicone generally has minimal encapsulation stresses and great high temperature and UV performances. However adhesion and chemical-barrier properties are lacking. There have been attempts to create hybrid polymers which combine the strength of epoxies and silicones. This presentation will attempt to capture the material challenges encountered in the laboratory and in the field.

Keywords: LED, Encapsulation, Epoxy, Silicone

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FABRICATION TECHNIQUES OF POLYMERIC MATERIAL FOR MICROELECTRONIC AND PHOTONIC APPLICATIONS.

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Nanotechnology is one of the fastest growing new areas in science and engineering to create new functional systems of nanoscale dimensions. The ability to fabricate structures with nanometric precision is of fundamental importance especially in electronic and photonic devices. Nanofabrication involves various lithographies to write extremely small structures. Radiation based technology using X rays, e-beams and ion beams is the key to a variety of different approaches to micropattering. An overview of selected polymer system and fabrication techniques for producing polymer waveguides for photonic application is presented. In UV lithography, various uv curable material can be employed with appropriate processing parameters of uv intensitites and curing time. The UV lithography can be used to construct waveguide and selection of developers are necessary to obtain patterns which followed similar fabrication process as in photoresist for microelectronic application. Existing nanostructure manufacturing techniques, such as photolithography and electron beam lithography, are suited for creating 2-D features. New development for 3D structures will also be presented which will lead to inexpensive mass production of such 3-D structures by employing rubber mask as one of its optical component. Nanoimprinting lithgography utilising mold embossment is another relevant processing technique to be discussed for producing fine structure. Direct write assembly techniques with lasers can also rapidly fabricate polymer materials into complex 3D shape without the need for expensive tooling, dies or lithographic masks. Recent advances in electron and laser writing techniques for writing polymer waveguide for photonic devices are also reviewed with emphasis on push toward finer feature sizes.

KEYWORDS: Lithography, Micropatterning, Nanostrucutre, Polymer Waveguide, UV Curing, Photonic.

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Small is beautiful – Innovations in Microelectronics Packaging Miniaturizations

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"Small is beautiful" came from E. F. Schumacher, a renowned British economist in the eighties to champion small and appropriate technologies. In this millennium, this cannot be more true as technologies are going to nano-scale and this has allowed Moore's law prophecy to be fulfilled. Hence, nanotechnology has made miniaturizations of devices real and without sacrificing performance. You might wonder how are the microchips of these miniaturized devices developed and manufactured. What are the materials used and how can these materials affect the performance of devices? Wonder no more! This paper answers these questions and explains the use of innovation in assembly packaging to miniaturize advanced microchip. It highlights the challenges and trends of assembly packaging based on the need to meet Moore's Law. In general, the increasing transistor numbers, I/O counts and electrical performance of Moore's Law allow the reduction in microchip dimensions, enhancement in microchip features and increment of package performance. On the other hand, the challenges are assembly complexities, insufficient real estate to handle tiny devices and high thermal requirements. In an attempt to provide an insight on how assembly packaging affects the performance electronic packages, this paper discusses on topics such as fine line spacing for high density substrate, robust lead-free interconnection solder and efficient thermal interface materials for heat management. It also entails the emerging need of the system-in-package and package-on-package technologies used for the hand-held & mobile internet devices. This exciting technology trend drives for lower cost, higher performance and smaller form factor requires significant innovation in research and development in microelectronic packaging. Small is indeed beautiful and exciting as well

Keywords: Packaging, high density interconnection (HDI), Moore's Law

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On the Combination of Braiding and Weaving Technologies for Fabricating Continuous Natural Fiber-Reinforced Composites

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Comingled yarns are normally used to improve impregnation of thermoplastic resins into inorganic fibers during the fabrication of composites. However, natural fibers are inherently short and have to be spun in order to obtain continuous yarns. Since the surface of these yarns is neither smooth nor symmetrical, commingling these yarns with resin fibers is especially difficult. Therefore, in this study, the micro-braiding technology was employed where the resin fibers are braided around the reinforcement natural fiber yarn to yield an intermediate material known as the "micro-braided-yarn". In order to obtain bi-directional reinforcement alignment, the micro-braided yarns were woven in 0^{o}-90^{o} orientation to yield fabrics, which were then compression molded into composite plates. Observations on the impregnation state and evaluation of mechanical properties were performed. From these observations, the relationship between molding conditions and the mechanical performance of thecomposites was established.

Keywords: Continuous natural fiber, Thermoplastic resin, POM fiber, PLA fiber, Mechanical properties

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Mechanical and Bonding Behavior of Polymeric Groutas a Function of Temperature and Surface Conditions

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Grouted connections are commonly used to effect repairs on damaged or aged pipelines in the oil and gas industry. The grout is injected into the annulus of a pipe sleeve connection so that loads can be transmitted through the grout to the (undamaged) sleeve thus bypassing the damaged area requiring repair. Other uses of the grout include acting as fillers for large cracks and wall losses due to corrosion. In this study a commercially available epoxy grout was investigated for its mechanical and bonding behaviors' with respect to operating temperature and steel substrate surface conditions. The grout is a two-part system of resin and hardener, and according to the manufacturer full cure is achieved within 7 days under ambient (circa 25°C) room temperature conditions. The tensile strength and stiffness as well as the shear strength of the grout were studied as a function of increasing test temperature to simulate a range of possible operating conditions of the pipelines. The effects of these temperature changes and those of surface preparation procedure on adhesion performance of the grout to the steel substrate were further investigated using both single lap shear and transverse adhesion tests. In the latter case, the metal substrate is exposed to seawater for different lengths of time after they had been first grit blasted thus simulating the probable delay, following surface preparation, in a pipeline repair of several days. From the tests, it was found that the grout suffers dramatic changes in strength and stiffness with relatively small temperature increments. With respect to the bonding performance of the grout to steel substrates, degradation is evident even with minimal exposure to seawater due to onset of corrosion. These results are described and discussed based on heat and fractographic analyses. Finally a large scale grouted connection test is described to illustrate the intended use of the polymeric grout.

Keywords: Polymeric grout, Temperature, Bonding surface conditions, Mechanical properties, Thermal analysis

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Laser Transmission Welding Technique Utilizing Change of Absorption Coefficient of Material by Moisture Adsorption

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Water molecule has characteristic absorption band in infrared region from 2.78 to 3.13 microns, and this absorption band is caused by OH vibration. On the other hand, Er:YAG laser has the wavelength of 2.94 microns and it is efficiently absorbed by the water molecules. In this study, a new laser transmission welding technique that uses the radiation absorption coefficient change of an amorphous polymer caused by water molecules adsorption is proposed. Experimental study and numerical simulation were carried out to investigate the feasibility and to discuss the

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THE EFFECT OF ADDING POLYSILANE INTO CYCRO-OLEFINS

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In this study, the optical and mechanical properties of cyclo-olefin polymers (COPs) which were added several kinds of polysilane or silicones were investigated. When adding low molecular weight polysilane (PMPS) into COPs upto 20wt%, the transparency of the COP blends was maintained and, at the same time, their refractive index values increased with an increase of PMPS content. On the other hand, when adding polysilane with high molecular weigh or silicone into COPs, those films became cloudy even with 10wt% of the additives, indicating that they cannot be dispersed homogeneously. Besides the glass-transition temperature (Tg) of COPs can be controlled by adding PMPS, and its decline ratio of Tg was almost proportional to the PMPS content. This result indicated that PMPS can play the role of plasticizer for COP materials. For the molecular motion in the glassy state of COPs, however, the activation energy of their enthalpy relaxation increased by adding PMPS, indicating that PMPS hinders enthalpy relaxation.

Keywords: Cyclo-olefin polymers, Polysilane, Glass-transition temperature, Mechanical properties, Viscoelastic relaxation

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Super High Clarity PP for Baby Feeding Bottle & Sport Drink Bottle

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Polypropylene is one of the versatile polymers with good balance physical properties, excellent chemicals resistance, thermo & electrical properties and it is being used widely in a broad range of applications like packaging, houseware, automotive, electrical & electronic, medical, personal care, appliances, textile, stationery, etc. The discovery of clarifying agents had further expanded the application of polypropylene into applications that require good clarity and transparency which have been dominated by glass and amorphous polymers like PS, PMMA, PC, PET, PVC, etc. Clarified PP had earned commercial success in clear containers, syringes, beverage bottles, medical containers, and to some extent the baby feeding bottle market. However, the baby feeding bottle is dominated by polycarbonate (PC) due to a crystal clear appearance, as the "old generation" clarified PP is unable to match with PC, in particular for the thicker products like baby feeding bottle & sport drink bottle. The recent invention of new generation clarifying agent and modification on the PP base resin has further narrowed the gap between the clarified PP and PC. With the issue of bisphenol A (BPA) in the media headlines recently when several governments issued reports questioning its safety, and some retailers pulled products made from it off their shelves, the new super high clarity PP seems to be the excellent option for the baby feeding bottle. As PP is a semi-crystallized material with narrower processing window compared to those amorphous material, this paper also discuss the processing guidelines and processing parameters that allow conversion from other materials like PC, etc with super high clarity PP.

Keywords: PP, Super high clarity PP, SHCPP, BPA free, ISBM, Baby bottle

ABSRACT FOR POSTER PRESENTATION

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Mechanical Properties of Cellulose Nanofiber Composites

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Environmentally friendly nanocellulose composites were newly developed by combining two dispersion-type biodegradable resins: polylactic acid (PLA) and chemically modified starch, and cellulose nanofibers of two kinds. The nanoscale cellulose fibers were prepared by homogenization of wood pulp. The 10–100 nm diameter nanocellulose fibers have a web-like network microstructure. The mixture of dispersion-type biodegradable resin and cellulose nanofibers was dried in an air-circulating oven to make composite preform sheets. Nanocellulose composite samples were fabricated by press-forming of the preform sheets. Their mechanical properties were evaluated using room-temperature tensile tests. The composite composed of PLA-based resin and highly homogenized cellulose nanofibers showed higher mechanical properties than those of starch-based resin and coarse cellulose fibers. It is suggested that coarse cellulose fibers act as a defect, resulting in low mechanical properties. Maximum tensile strength reaches approximately 90 MPa at fiber weight contents of 50% by weight. This mechanical property is comparable to that of conventional glass-fiber-reinforced plastics.

Keywords : Cellulose Nanofiber, Poly Lactic Acid, Starch, Homogenization, Biodegradable Composites

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Development of Solid Polymer Electrolytes Using Supercritical Carbon Dioxide

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We have been studying on effective use of supercritical carbon dioxide (scCO2) for preparation of high-performance solid polymer electrolytes (SPE). In this study, we prepared scCO2-treated polyether-salt complexes under different treatment conditions, and measured elapsed time dependence of the ionic conductivity. The samples treated with 40 and 80 min showed good stability and the aggregation of ions was inhibited. On the other hand, we prepared supercritical CO2-treated SPE/clay nanocomposites and measured their conductivities. The conductivity of scCO2-treated sample (PCO2) was clearly higher than that of the original (Pori) and the difference was more than two orders of magnitude at 30 $^{\circ}$C, whereas the d-spacing of dispersed clay in PCO2 was almost the same as the value for Pori. Moreover, we first synthesized CO2/epoxides copolymers and evaluated as novel ion-conductive materials. The obtained CO2/phenyl glycidyl ether copolymer with LiTFSI showed relatively high conductivity (1.7×10-5 S/cm, at 30 oC), and the value was higher than that of the polyether electrolytes.

Keywords: Solid polymer electrolyte/ Ionic conductivity/ Carbon dioxide/ Supercritical fluid

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The study of surface properties in injection moldings

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The results of a new evaluation method in spectrum analysis proposed in this study were in agreement with the observation results, and showed the validity in the numerical evaluation of the surface state of emboss. Moreover, the polymer surface temperature and pressure obtained from the numerical analysis showed the good agreement with the tendency of evaluation results. From the experimental and numerical results, it was considered that the new evaluation method can be proved to be useful for the surface properties of emboss and can be applied to the optimum mold design with emboss.

Key words: Injection molding, Surface properties, Spectrum analysis, Numerical analysis

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The study on the influence of a resin temperature and pressure on the surface properties of the injection moldings.

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Key words: Injection molding, Surface properties, Multi cavities, Spectrum analysis

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PP/PS/PMMA (80/10/10) Ternary Blend Foaming: Morphology and Cell Structure

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The aim of this work is to study foamability and cell structure of a Polypropylene (PP)/Polystyrene (PS)/ Polymethyl methacrylate (PMMA) ternary polymer blend foam. The effects of its blend morphology and rheology on the cell structure of the ternary blend foam were investigated. The encapsulation-type morphology was formed in the blend with the PP/PS/PMMA ratio of 80/10/10, where PMMA composed core and PS made the shell of spherical domain in PP matrix. The batch pressure quenched foaming of the ternary blend with supercritical carbon dioxide (CO_2) was conducted in the temperature range from 60 to 160°C to observe the controllability of bubble location and size. At the foaming temperatures lower than 100°C, the blends were not foamed. In the range from 100 to 150°C, PMMA/PS core-shell domain was unfoamed and kept as their spherical shape. However, void space less than 20 µm in diameter was created around the PMMA/PS domain. Over 150°C, the number of bubbles as well as bubble size increased and the void space around the PMMA/PS domain could not be differentiated from bubbles nucleated in PP matrix. These experimental results showed that the cell structure could be controlled by foaming temperature, interfacial tension and viscoelasticity of each domain in the ternary blend.

Keywords: Ternary polymer blend, foaming, bubble nucleation, interfacial tension.

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Effect of Surface Texture on Scratch Behavior of Injection Molded Plastics

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Scratch behavior of injection-molded polycarbonate (PC) with tree different spherical shape pattern and pattern distance was studied. In this study, a linearly increasing load scratch test was performed based on ISO 19252. The results showed that the critical normal load for onset of pattern shape change decreased with increasing the distance between spherical patterns. Polarize-light optical microscope (POM) was used to observe the sub-surface damage. The correlation between the critical normal load and the sub-surface damage is discussed to determine the optimum surface pattern design for scratch resistance.

Keyword: scratch behavior, subsurface analysis, surface texture, injection molding

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Pellet Morphology during the Compounding Process of Recycled Poly(ethylene terephthalate)/Recycled Polypropylene Blends

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ABSTRACT: Blending of recycled polyethylene terephthalate (RPET) from waste bottles with polypropylene (PP) was performed in an attempt to enhance the processability of RPET. The idea of blending RPET with PP sprouted from the intention of recycling PET bottles together with their PP-based caps. Therefore, preliminary blending of RPET with PP (RPET/PP) was performed at various PP and compatibilizer contents. The incorporation of compatibilizers reduced the PP particle size and improved the overall homogeneity of the blends. This effectively reduced stress concentration points and enhanced the mechanical performance of the blends. More importantly, the incorporation of PP into RPET significantly increased the degradation temperature of the blends provided the dispersion of PP phase in RPET was excellent.

KEYWORDS: Recycling, Polymer Blends, Thermal Stability, Compatibilization

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Impact Fracture Modes of Hairline-Cracked Injection Moldings of Recycled Polyethylene Terephthalate

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Investigation was on the impact fracture behavior of injection moldings from recycled and neat Polyethylene terephthalate (PET). Two groups of injection-molded plaques were fabricated at different mold temperatures set at 30 and 150°C respectively. The effects of various depths of hairline crack on the impact fracture modes of the molded parts were studied in order to determine their maximum fracture load and energy. The center point of the surface of PET plaques measuring 10 x 10mm on all sides and 3mm thick were introduced with 6mm long hairline cracks. The depths of the cracks were varied from 5-60□m. Drop weight impact test was conducted on both the un-cracked and cracked PET specimens by the use of Instron Dynatup 9250HV attached with a 12.90mm diameter tup, and drop weight of 6.492. Impact velocity was set at 3.9306m/s with energy of 51.22J and test height of 0.8064m. The loss of impact load and fracture energy of the samples was correlated to the various crack depths to determine if hairline cracks are detrimental to PET injection-moldings. Results show that both the impact load and energy to fracture of the materials decreased progressively as the hairline crack deepens. The un-cracked sample showed high fracture resistance as they fractured in a ductile manner; however, at a□hairline crack depth of 10□m the materials fractured in a brittle manner

Keywords: RPET/VPET, Hairline crack, fracture energy, Impact strength, Saicas.

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Hydrothermal Aging of Jute/PP Injection Moldings

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This study dealt with the effects of water immersion on tensile properties of jute fiber reinforced polypropylene (PP) composites. The long fiber type jute/PP pellet and neat PP pellet were used as materials and the jute/PP specimens with different fiber content were prepared by injection molding with dry-blending of jute/PP and neat PP pellets. All the specimens were aged in hot distilled water at 80°C, and after the fixed periods of aging, the weight changes and the tensile properties were measured. The weight gain by water absorption was significantly affected by the fiber content. The specimens with the jute fiber content of 30wt% and more easily absorbed the water and it reached more than 10%. In these specimens significant material loss by aging was also occurred. The tensile strength after aging decreased remarkably in the specimens with the jute fiber content of 30wt% and more, and all the jute/PP composites showed the lower strength than neat PP after the aging of 1000 hours.

Key words: Jute fiber/polypropylene, Hydrothermal aging, Water absorption

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Influence of Particle Size on Filler Dispersion in PMMA/Silica Micro Injection Moldings

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Micro-injection moldings of poly(methyl methacrylate) filled with silica of various particle sizes ranging from 5 to 50 μm were fabricated. The distribution of the silica particles throughout the moldings was found to be significantly different, i.e. a more homogeneous distribution of fillers was evident as particle size decreases. Fracture properties, fracture surface appearance and transparency were significantly affected by the state of filler distribution.

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Fabrication of Micro-pattern of Quartz Glass in Injection Molding Process

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Micromolding with microscale surface features and thin-wall plates of the quartz glass/polymers composites were performed to fabricate a new micro-fluidic plate with glass. Effects of process parameters on processability and surface replication of the molded parts were evaluated. The replication ratio and internal morphology of molded green and sintered microparts were analyzed using SEM and a confocal laser scanning microscope. During sintering processes, the green molded composites shrank with removal of binder polymer. The internal morphology affected shrinkage of green molded composites. The surface replication ratio of molded and sintered parts showed high values. Sintered molded parts were produced with a high aspect ratio of 3.4 and 10 μm micro-line width.

Key words: Injection micro-molding, Quartz glass, Micro fluidic device, Micro-surface pattern

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Mechanical Properties of Nano-matrix structured Material

Seiichi Kawahara, Keiichi Akabori and Yoshimasa Yamamoto

Preparation of a model natural rubber dispersed in nano-matrix was made by graft-copolymerization of deproteinized natural rubber latex with styrene, using *tert*-butyl hydroperoxide / tetraethylenepentamine as an initiator. The products were characterized by ^{1}H-NMR spectroscopy and size-exclusion-chromatography after ozonolysis. The grafting efficiency of styrene was more than 90% under the best condition of the graft-copolymerization. The morphology of the film specimens, prepared from graft-copolymers, was observed by transmission electron microscopy after staining the films with OsO_4. Natural rubber particle of about 0.5□m in diameter was dispersed in polystyrene matrix of less than 15 nm in thickness.

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Preparation of Natural Rubber Fine-powder from Electrospinning for Polymer Toughness Modifier

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Natural rubber fine-powder in submicron range was prepared by electrospinning method. The effects of concentration of latex, supply voltages and electrospinning distance were investigated. The concentration of NR latex were varying form 50 to 90 w/v%, while 20-25 kilovolt of supply voltages and 8-12 centimeter of electrospinning distance were operating condition. After electrospinning and analyzed by scanning electron microscope (SEM), it was found that latex can be formed in droplets with difference shape and size. However, the droplets are not isolated and some droplets are agglomerated like sheet. From the effects of parameters of electrospinning process, it was found that increasing concentration of latex, large size of fine-powder was formed. The size of powder was reduced to a minimum value with increasing the voltage. An increasing electrospinning distance was no significantly effect on the size of powder but improved the sphericity of the powder.

Keywords: Electrospinning / Natural rubber / Powder

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A study on effect of hardener for prepared composite wood from glutinous rice flour.

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Composite wood was prepared from various amounts of hardener, glutinous rice flour, coconut fiber and corn fiber. The aim of this work was to investigate effects of the amount of hardener on properties of the composite wood. The coconut fiber was prepared by reflux with sodium hydroxide solution (15 %w/v) at 90 C for 10 minute. Subsequently, the coconut fiber was bleached with hydrogen peroxide (15% v/v) to obtain clean and brown fiber. The coconut fiber was mixed with corn fiber at 2:1 ratio, then adding the glutinous rice flour and hardener at various ratios from 5-20% (w/w). The wood composite particle board was conducted by hot pressing process. The FT-IR technique was used to characterize the chemical structure of the composite wood. The mechanical properties of the composite wood were measured using a tensile test. The results show the average values of tensile strength, modulus of rupture and modulus of elasticity were increased

Keywords: hardener , particle board,elastomeric, coconut fiber

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STUDY OF HIGH VOLTAGE INSULATOR USING NATURAL RUBBER

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Thailand is considered to be one of the most famous major rubber distributors in the world. Most of the natural rubbers in Thailand are generally produced for automobile industry, construction industry, agricultural industry and etc. One of the excellent properties of natural rubber is its low electrical conducting, which can be transformed and made as insulator. In this regard, we try to study and modify natural rubber in order to apply as a high voltage electrical insulation. This insulator can be made by combination of natural rubber and Ethylene-Propylene Diene Rubber. These combinations will naturally make the insulator more resistance to thermal degradation and ozone more. This research is aimed to make an experiment on natural electrical insulator by combining natural rubber (NR) with Ethylene-Propylene Diene Rubber (EPDM) with the ratio of 100/0, 80/20, 60/40, 50/50, 40/60, 20/80 and 0/100, respectively. All rubber compounds were mixed through two roll mill to prepare vulcanized rubber compounding. The electrical properties of resulting rubber were investigated. It was found that the highest surface resistivity and dielectric strength was $1.4x10^{16}$ Ω/cm^2 and 20.42 kV/mm, respectively. At NR/EPDM (60/40), the dielectric strength was found to be 9.94 kV/mm which was high enough to be an insulator for high voltage pressure at 380/220 Volts. The mechanical properties of the rubber compounding were observed. It was found that mixture of EPDM 50 wt% showed the highest hardness of 63 Shore A. The thermal properties are incredibly important for the resistance improvement to thermal aging of natural rubber.

Keywords: Rubber Insulator, Natural Rubber, High Voltage

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Characterization of Cell Density with Principle of Critical Bubble Lattice and Variation of Cell Cross-Sections for Isotropic Polymeric Foams

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In this study, models for estimate of cell density of isotropic polymeric foams were developed and discussed about reasonable. The basic morphological unit of closed-cell foams is the gas-filled cavity surrounded by cell walls and struts. Typically, these cells are pentagonal dodecahedral cavities. This work introduced the principle of critical bubble which is the maximum gas bubble that able to be filled in the cells, the packing of critical bubble of pentagonal dodecahedral cells was related to atomic packed structure in FCC structure. Therefore, one can apply the equation which used to estimate cell density of FCC atomic packed structure to the foam structure. However, the relations between size of critical bubble and measured cross-sectional area of windows were developed in two cases: One based on ideal case, perfect cross-section of micrograph which all cells were cracked in the middle of cell and hexagonal windows were shown for maximum result. Second was based on actual case, considering the variation of non-perfect cross-section of micrograph which is often observable in general polymeric foam characterization. From the obtained foam micrographs, comparison of the conventional model and two critical bubble based models illustrated that the conventional model for high density foams is similar to the ideal case. For low density foams, non-perfect cross-section model provided reasonable estimation of bubble density while the conventional model showed over estimated results because of its ignoring the non-perfect cross section of micrograph.

Keywords: Foam morphology analysis, Cell density, Polymeric foams, Isotropic foam

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The Influence of Mold Temperature on Mechanical Properties of Rigid Polyurethane Composite Foam

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Rigid polyurethane composite foams (RPUCF) have been extensively used in many applications such as construction, thermal insulation, footwear, furniture and automotive industries. In automotive area, RPUCF are light weight polymer suitable for bumpers and exterior part. Suitable RPUCF can improve mechanical properties by setting optimum mold temperature. This study investigates the effect of mold temperature on mechanical properties of RPUCF. The RPUCF were prepared with polyether polyol and 4, 4'diphenylmethane diisocyanate (MDI) in the ratio of 1:2 at density 1.0 g/cm3. RPUCF were performed by using reaction molding into a preheated aluminum mold by various temperatures at 40, 50, 60, 70, and 80oC, respectively. The mechanical (flexural and impact) and thermal (heat deflection temperature) properties of RPUCF samples were investigated. The microscopic structure of RPUCF was observed using scanning electron microscopy (SEM), then analyzed SEM picture by image processing program, sequentially. It was found that heat deflection temperature and impact strength trended to be improved by increasing mold temperature. On the other hand, their flexural strength and modulus were optimized at mold temperature 60oC.

Keywords: Rigid polyurethane composite foams (RPUCF), mechanical properties, mold temperature, image processing program, heat deflection temperature

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Effect of Uniaxial Cold Rolling on the Structure and Properties of Poly(Butylene Succinate)/Organo-Montmorillonite Nanocomposites

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To date, study on molecular orientation of polymer nanocomposites is rather limited. In fact, polymer nanocomposites offer great potential of enhanced properties such as strength and ductility via molecular orientations of polymer chains. In this study, structure and properties of poly(butylene succinate) (PBS) and its nanocomposites were modified by subjected to uniaxial cold rolling. Before undergoing cold rolling process, PBS and its nanocomposites were prepared via melt mixing process by using internal mixer, followed by compression molding into sheet form. The variation of PBS nanocomposites' properties as a function of the rolling conditions, i.e. thickness reduction was studied. Changes in mechanical properties were studied in both machine direction (MD) and transverse direction (TD). Along MD, distinct improvements in tensile strength and elongation at break were observed. Greater thickness reduction had resulted in higher strength and ductility (elongation at break) due to increased molecular orientation. However, tensile strength degraded at TD. TEM micrographs of rolled samples show a better clay exfoliation due to the delamination of clay stacks during rolling action. Wide angle X-ray diffraction (WAXD) is a method that had been widely utilized in the study of molecular orientations. The presented WAXD results reveal a better molecular orientation at higher thickness reduction. Besides that, crystallinity found to be reduced after cold rolling by WAXD and differential scanning calorimetry (DSC), mainly due to the destruction of crystalline region.

Keywords: Poly(butylene succinate), Nanocomposites, Molecular Orientation, Cold Rolling.

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Water Absorption of Poly(methyl methacrylate)/Hydroxyapatite Composites

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Poly(methyl methacrylate) (PMMA)/hydroxyapatite (HA) composite has potential application in denture base materials. The denture base materials should exhibit good mechanical properties and dimensional stability in moist environment. Silane coupling agent [3-(trimethoxysilyl) propyl methacrylate (γ-MPS)] was used to treat the HA fillers in order to enhance the interfacial interaction between the PMMA and HA. In this research, the kinetics of water absorption and their effects on the flexural properties for PMMA/HA composites was studied at 30^{o}C for a immersion duration of 2 months. The mathematical treatment used in analyzing the data was the single free phase model of diffusion, which assumed Fickian diffusion and utilized Fick's second law of diffusion. The kinetics of water absorption of the PMMA/HA composites conformed to Fickian law behavior, whereby the initial moisture absorption follows a linear relationship between the percentage gain at any time t and $t^{1/2}$, followed by saturation. It was found that the equilibrium moisture content and the diffusion coefficient are depending on the γ-MPS concentration on PMMA/5HA composites. The lower equilibrium moisture content of PMMA/5HA is due to the hydrophobic behavior of γ-MPS. The retention ability in flexural modulus and strength of PMMA/HA composites upon subjected to water absorption are considerable good. The reduction of flexural strength of the PMMA/HA composites after water absorption could be attributed to the plasticizing effect of water molecules.
Keywords: Poly(methyl methacrylate), hydroxyapatite, water absorption, flexural properties

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Synthesis and Studies the Effect of Phenyl Side-Chain Content on High Refractive Index of Polysiloxane Resin

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A series of high refractive index of α,ω-vinyl silyl terminated polydimethylsiloxane-co-polydiphenylsiloxane was synthesized by the equilibration ring opening – anionic polymerization of cyclic organo-siloxane oligomers in the present of 1,3-divinyltetramethyldisiloxane as terminating agent. Structural modifications were characterized by use of FTIR, H-NMR, 13C-NMR, Si-NMR, solution viscosity and elemental analysis. UV-visible spectroscopy was analyzed which reveal a good transmittance in the region 400 – 750 nm radiation for all polysiloxanes.The presence of diphenylsiloxane unit results in a linear increase of the refractive index of the resin. These features favor good application as encapsulant for high brightness LED (HBLED) packaging.

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Effect of Alkali Treatment on the Mechanical Properties of Polypropylene-Kenaf Fiber Composites.

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Kenaf fibers were alkali treated to improve their sustainability for use as reinforcements in composite materials. The chemical treatment using sodium hydroxide (NaOH) was carried out to modify the fiber properties. The effects of different concentrations from 1, 3, 5 to 10 wt% were investigated. In alkaline treatment, kenaf fibers were immersed in NaOH solution at 1, 3, 5, and 10wt% concentration for 1 h. Kenaf fiber reinforced polypropylene composite were produced by using internal mixer and hot press machine. The effect of different concentrations of NaOH on the tensile strength and modulus were investigated. At 5wt% NaOH treated kenaf fiber reinforced polypropylene composite showed better tensile strength than 10wt% NaOH treated composite. This is because at higher alkali concentrations, excess delignification of natural fiber occurs resulting in a weaker or damaged fiber. The surface morphology and fractured surface of kenaf fibers reinforced polypropylene composites were monitored by scanning electron microscopy (SEM) studies. The effects of fiber treatment on the kenaf fiber surfaces were also studied using Fourier Transform Infrared (FTIR). There was an absorption in the untreated fiber at about 1738.3 cm^{-1}, which vanished in the NaOH treated fibers. These results indicate that alkali treatment leads to the partial removal of hemicelluloses. The optimum composite, consisting of 5wt% alkali treated kenaf fibers reinforced polypropylene composite, was found to have a tensile strength of 12.55 MPa and modulus of 1.42 GPa.
Keywords: Kenaf fibers, NaOH, Tensile strength, SEM, FTIR

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ENVIRONMENTAL DEGRADATION STUDY OF PULTRUDED JUTE FIBRE REINFORCED UNSATURATED POLYESTER COMPOSITES USING DYNAMIC MECHANICAL THERMAL ANALYSIS

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This paper reports the environmental degradation effect on the properties of pultruded jute fiber reinforced composites (PJRC). Water absorption tests were conducted by immersing PJRC specimens into three different environmental conditions at room temperature for a period up to three weeks. Water absorption curves were obtained and parameters such as diffusion coefficient (D) and maximum moisture content, M_m were determined from the curves. Water absorption characteristic of PJRCs were found to follow a so-called pseudo-Fickian behavior and successfully predicted using Fick's Law. The dynamic mechanical property of PJRC was found to be highly affected by the presence of absorbed water in the specimens.

Keywords: Fiber, Polymer–matrix composites (PMCs), Environmental Degradation, Dynamic mechanical thermal analysis (DMTA), Pultrusion

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MEASUREMENT OF DYNAMIC MECHANICAL PROPERTIES OF PULTRUDED NATURAL FIBRE REINFORCED COMPOSITES USING SPLIT HOPKINSON PRESSURE BAR APPARATUS (SHPBA)

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The paper presents results on dynamic mechanical properties of Jute, and Kenaf reinforced composites (JFRC and KFRC) at various strain rates using compression Split Hopkinson Pressure Bar apparatus (SHPBA). In the beginning of the SHPB test, the reliability of the signal is demonstrated. Besides that, the method of determining strain rate was also reported. The stress-strain response for both pultruded natural fibre reinforced composites at dynamic strain rates of nearly $1400s^{-1}$ are illustrated and then compared with those exposed at static of strain ($1.2x\ 10^{-3}\ s^{-1}$). From the result, it was clear that the strain rate has a significant effect on the value of dynamic compressive properties of both pultruded natural fibre composites. It has also been found that JFRC recorded the highest value of compressive modulus and 2.5% flow stress as compared to KFRC over the range of the strain rate investigated.

Key words: Split Hopkinson Pressure Bar apparatus (SHPB); Strain rate; Natural fibre composites; compressive modulus; 2.5% flow stress.

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Comparison on the Properties of Phenolic Hollow Microspheres (PHMS)/ Woven Glass Fabric and Woven Basalt Fabric Filled Vinyl Ester Composites

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Studies on the effect of phenolic hollow microspheres on the specific mechanical properties and thermal properties of glass and basalt woven fabric reinforced vinyl ester composites, have been carried out with different filler contents (1% and 5% in weight). Samples were prepared using hand lay-up and vacuum bagging method. Three-point bending and Izod impact tests were carried out to determine the mechanical properties of the composite materials. Thermogravimetric analysis and dilatometry tests were performed to determine the thermal properties and CTE of the composites, respectively. The specific flexural and specific impact strengths of the composites were marginally increased with the addition of PHMS; however, it was at the expense of reduced specific flexural modulus. The thermal stability of the neat vinyl ester was improved with the addition of woven glass, but was consequently reduced with the further inclusion of PHMS. SEM observations identified the presence of the combined failure mechanism of fibers and PHMS. In short, the major reinforcing effect of the woven fiber-reinforced vinyl ester composites is governed by the type of fiber used, while the addition of PHMS enhanced the ductility of the composites.

KEYWORDS: Woven fabric, Phenolic hollow microspheres, Specific mechanical properties, Thermal properties.

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PROPERTIES OF BIOACTIVE FILLERS FILLED POLYMETHYLMETHACRYLATE (PMMA) BONE CEMENT COMPOSITE

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Polymethylmethacrylate (PMMA) bone cement is used extensively for fixation of implants such as artificial hip and knee joints with the living bone. In this present study, we developed a new bioactive glass ceramic which has been synthesized based on Na_2O-CaO-SiO_2-P_2O_5 system. Commercial acrylic bone cement was modified by incorporating different filler loadings of particulate bioactive filler; glass ceramic and hydroxyapatite (HA). PMMA bone cement containing 0, 4, 8, 12, and 16 wt% of glass ceramic and HA was prepared. In order to achieve a proper and homogenous distribution of bioactive fillers in the polymeric matrix, commercially low viscosity cement (Palacos LV®) were prepared by mixing the powder and liquid components using Stryker Mixevac III vacuum mixing system. The effect of bioactive fillers and different filler loading on the settings and mechanical and thermal properties were evaluated. The peak temperature during the polymerization of bone cement was observed to decrease with the increase in the filler loading. In addition, flexural strength, modulus, and void content were evaluated. It was found that the flexural strength decreased as the filler loading increased. In general, it can be concluded that the properties of commercial acrylic bone cement are governed by types of bioactive fillers and filler loading been used in the bone cement system.

Keywords: Bone Cement; PMMA; Hydroxylapatite; Vacuum Mixing; Mechanical Properties

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Processing And Compressive Strengths Of Epoxy Syntactic Foam Incorporated With Epoxy Hollow Spheres

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Two-phase and three-phase epoxy syntactic foams were manufactured by distributing epoxy hollow spheres within epoxy resin matrix. The produced foams were characterized for compressive properties in the present research. The syntactic foams were prepared by embedding epoxy hollow spheres into the epoxy resin matrix and were cured for 24 hours. These two types of syntactic foams contained similar size of epoxy hollow spheres but having different type of morphology. For three-phase system, sodium bicarbonate was used as the foaming agent to form gaseous voids. It is observed that the compressive strength for two-phase system is higher than three-phase system. Results also indicated that compressive strength of syntactic foam decrease with increasing gaseous void fraction. It is shown that the gaseous voids do not contribute to the strength properties of the syntactic foams.

Keywords: Epoxy Syntactic Foam, Epoxy Hollow Spheres, Foaming Agent, Compressive Strength, Gaseous Voids.

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Flow Behaviour of Polypropylene-Kaolin Composites at Various Filler Loading, Temperatures and Multiple Extrusion Cycle

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A study of kaolin addition in polypropylene (PP/Kaolin) melt with incorporation of PPgMA as a coupling agent was carried out to characterize its flow behavior at various filler loading, temperatures and during multiple extrusion cycles. The compounds are prepared by melt mixing using heated two roll-mill at 185°C, while the compounded composites were put through the single screw extruder to evaluate its melt flow properties. Generally, the PP/Kaolin composites exhibit a shear thinning behavior and apparently, the apparent viscosity (η_{app}) decreased at 5 wt% loading of kaolin. Further increase in kaolin loading resulted in increasing value of η_{app} for the composites. Besides it is also appear to be strongly dependent on temperatures where the, η_{app} are declining as the temperature increases. In spite of that, it is found at constant screw speed, increases in extrusion cycles leads to increasing value of η_{app} due to formations of possible croslinking generation throught the presence of maleic anhydride group attach on the PPgMA.

***Key Words**:* composites; polyolefins; processing; rheology

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TENSILE PROPERTIES AND MORPHOLOGY OF LLDPE/PVA BLENDS CONTAINING SILANE COUPLING AGENT (Si 69) AS COMPATIBILIZER

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Tensile properties and morphology of blends made from linear low density polyethylene (LLDPE) and polyvinyl alcohol (PVA) has been investigated. Silane coupling agent (Si 69) was used as a compatibilizer. The blends were melt mixed using a Haake Rheometer at 150°C and 50 rpm for 10 minutes. Results show the tensile strength and elongation at break decreased with increasing polyvinyl alcohol content in the blends, while the Young's modulus increased up to certain level of polyvinyl alcohol content and then decreased. The incorporation of Si 69 increased the, tensile strength and Young's modulus but decreased the elongation at break of the blends. The interfacial adhesion between polyvinyl alcohol and linear low density polyethylene was improved by the incorporation of Si 69 as demonstrated by morphology study using SEM.

Keyword: Linear Low Density Polyethylene; Poly(Vinyl Alcohol); Morphology, Silane Coupling Agent

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Effect of Silane Coupling Agent on Mechanical and Morphological Properties of Polypropylene/Zeolite Composites

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Polypropylene/zeolite (PPZ) composite with different loadings of zeolite (5-25 vol %) were prepared using Thermo Haake Polydrive internal mixer and were then compression molded according to standard test specimen. The aim of this work is to investigate the effect of vinyl silane coupling agent on mechanical and morphological properties of PPZ composite. Prior to mixing process, zeolite was grinded by ring mill into a powder form. Tensile and Izod impact test were performed to determine the mechanical properties of vinyl silane treated polypropylene/zeolite (PPZ VS) composite. The results were then compared to untreated PPZ composite. Morphological study was also done on the tensile fractured surface using a scanning electron microscopy (SEM). A significant improvement in tensile strength (TS), elongation at break (EAB), tensile modulus (E) and impact strength (IS) are found in PPZ VS composite. The enhancement was attributed to better interfacial adhesion between the treated zeolite and PP matrix hence leads to better mechanical properties of the PPZ VS composite. The obtained experimental values of tensile modulus are then related to the theoretical predictions using a Halpin-Tsai equation. The theoretical prediction results in greater values of tensile modulus compared to the experimental values. SEM result show that the adhesion between treated zeolite and PP are better than untreated zeolite. This phenomenon was contributed to the improvement in mechanical properties of PPZ VS composite.

Keywords: Zeolite, Vinyl Silane, Composite

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Water absorption study on PVA/corn starch blend composites

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In this work, Polyvinyl Alcohol (PVA) and Corn Starch (CS) were prepared using solution casting method. Then, the films were tested on water absorption using distilled water and acidic solution. This test was performed within 30 days until it reach its equilibrium states. The water absorption of the film was calculated and graph of moisture absorption (M_t) versus immersion time ($t^{1/2}$) was constructed. An initial linear relationship between M_t and $t^{1/2}$ was observed in each case, followed by saturation. It shown that absorbed water content increased with increasing immersion time. This indicates that water absorption behavior of PVA/CS blend film obeys Fick's Law. A rapid moisture uptake was observed in first few days of immersion. The absorption of water is related to its rate of diffusion into the composites. From the result and graph, diffusivity, D value was calculated. The different value of diffusivity, D from the result can be attributed to the hydrophilic nature of the PVA and corn starch by presence of hydroxyl groups which are available in PVA for interaction with the water molecules. Pure PVA film shows the lower diffusivity, D value than the PVA/CS film. It is expected that the starch absorb moisture faster than those pure PVA. For the water solubility test, the graph shows that increasing in corn starch content decrease the water solubility. The higher corn starch content leads to decrease in water solubility because of its insolubility properties in water at room temperature.

Keywords: PVA, Corn starch, PVA/corn starch blend ratio, water absorption testing

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The Effect of Electron beam irradiation on Mechanical Properties of ENR compatiblized LLDPE/soya powder blends

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In the present study, the effect of electron beam (EB) irradiation on the thermal and mechanical properties of LLDPE/soya powder blends was studied. Epoxidised natural rubber with 50% mol epoxidation (ENR 50) was used as a compatibliser in the blends. LLDPE/soya powder blends were irradiated at different doses which are 15kGy and 30 kGy. Nonirradiated LLDPE/soya powder was used as control samples, tensile test and morphological test were carried out to evaluate the effect of electron beam irradiation on the blends. The tensile strength and Young modulus was improved with increasing doses of electron beam irradiation. However, the elongation at break (EB) of irradiated blends is lower than unirradiated blends. Scanning electron micrograph (SEM) indicates a better interfacial adhesion in irradiated blends compared to the control.

Keywords: LLDPE; soya powder; ENR 50; tensile properties; electron beam irradiation

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Fracture Toughness and Optical Properties of Epoxy/Organo-Montmorillonite Nanocomposites

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Epoxy nanocomposites were prepared by incorporating finely dispersed organoclays (1 to 5 wt%) in the epoxy resin by using *in-situ* polymerization. The fracture toughness of the nanocomposites which was characterized by single edge-notched bending (SENB) test was found increased monotonically with clay loading. The result correlated well with the observation of FESEM micrographs where the nanocomposite reinforced with 5 wt% of OMMT exhibited highest degree of plastic deformation, attributed to the high toughness imparted by the incorporation of OMMT. On the other hand, the optical property of the epoxy nanocomposites was studied quantitatively by measuring the lux value and qualitatively by a novel color spectral index. Both the measurements showed that the light transmittance was inversely proportional to the clay loading due to the increase in particle surface per unit volume. The quantitative measurement evidenced that there is about 30% reduction in optical transparency with the incorporation of 5 wt% of clay.

Keywords: Epoxy; Clay; Nanocomposite; Fracture toughness; Optical clarity

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Mechanical and Morphological Properties of Epoxy Clay Hybrid Nanocomposites

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The epoxy/glass fiber/organo-montmorillonite (OMMT) nanocomposites with different loading of OMMT (1-4 wt%) were prepared using hand lay-up technique. The glass fibers used is chopped strand mat, while the epoxy resin system is made of diglycidyl ether of bisphenol A (DGEBA) resin with cycloaliphatic amine as the curing agent. The effects of OMMT loading on the fracture toughness, flexural and morphological properties of epoxy/glass fiber/OMMT nanocomposites have been investigated. The methodology used for the flexural test is based on the ASTM D790 standard while the fracture toughness test is based on D5045-91a standard. It is found that at low concentration of OMMT loading≤(2 wt%), improvement in flexural and fracture toughness properties are evident. Fracture toughness and flexural properties decreased significantly beyond 2 wt% OMMT addition. Field Emission Scanning Electron Microscopy (FESEM) and X-ray Diffraction (XRD) were performed to characterize the morphology of the epoxy/glass fiber/OMMT nanocomposites. The XRD analysis showed that epoxy/glass fiber/OMMT (1-3 wt%) exhibit exfoliated structures while epoxy/glass fiber/OMMT (4 wt%) showed intercalated structures.

Keywords: epoxy, glass fiber, organo-montmorillonite, fracture toughness, flexural properties

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Effects of Hygrothermal Aging on Jute/Glass Fibers Reinforced Unsaturated Polyester Composites: Visual Appearance and Morphological Properties

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The effects of hygrothermal aging on the visual appearance and morphological properties of unsaturated polyester (UP) matrix, jute fiber reinforced unsaturated polyester (JF/UP), glass fiber reinforced unsaturated polyester (GF/UP) and jute/glass fibers reinforced unsaturated polyester (JF/GF/UP) hybrid composites were investigated. The UP matrix was prepared by casting method whereas composites were prepared by hand lay-up technique. Samples were hygrothermally aged in distilled water at 30°C, 60°C and 90°C for a period of 3 months. Colorimetry and field emission scanning electron microscopy were employed for samples before and after aging in the study. UP matrix shows poor resistance to color darkening during hygrothermal aging at all immersion temperatures due to susceptible hydrolytic degradation of ester linkage in the polymer chains. Hybridization of JF and GF has shown synergistic effects in terms of increased in lightness of composite upon aging. SEM micrographs revealed that severe surfaces deterioration on hygrothermally aged samples at 90°C immersion temperature. Uneven blistering and matrix cracking were observed on aged UP matrix due to the hydrolytic degradation on matrix. Severe matrix cracking, degradation at fiber/matrix interface indeed exposure of fiber surface were observed on exposed surfaces for JF/UP and JF/GF/UP hybrid composites due to the higher swelling index of JF during aging.

Keywords: Hygrothermal, Unsaturated Polyester, Jute/Glass Fibers Hybrid Composites, Physical Appearance

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Effect of different curing system on physico-mechanical and morphological of *in situ* vulcanization process of styrene-modified natural rubber (SNR)

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Different types of crosslinking agent and accelerators have added in styrene-modified rubber (SNR) compounded by two roll mill. Crosslinking agent and accelerators used are cyclohexylbenzothiazole-2-sulfeamide (CBS), zinc diethyldithiocarbamate (ZDEC), tetramethylthiuram disulfide (TMTD) and sulfur. For *in situ* vulcanization of SNR different loading of TMTD and sulfur has been introduced. Effect of activator (ZnO) and accelerator (ZDEC) as part of the formulation also has been investigated. The molten plastic of polystyrene is then mixed with 20% SNR vulcanizates (compounded with two roll mill or *in situ* vulcanization) for PS/SNR blends. The tensile properties, impact strength and morphology of the blends have been investigated. Results show that PS/SNR vulcanizates with ZnO, ZDEC and sulfur (1.5phr) from the process of *in situ* vulcanization give optimum improvement in the impact strength of the blend.

(Keywords: crosslinking agent, sulfur, *in situ* vulcanization, impact strength)

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THE EFFECT OF AGEING ON PERMEABILITY BEHAVIOR OF TOLUENE THROUGH NATURAL RUBBER

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The application of certain automotive parts and components usually expose to the high temperature combine with an aggressive substances such as gasoline, oil and cleaning liquid. Natural rubber (NR) cured with conventional and efficient curing system (CV and EV systems) had been carried out using laboratory sized two roll mills. The effect of heat ageing for 2, 4, 6, 9 and 12 days at 100^{o}C on tensile properties, swelling measurement and permeability behavior of toluene at room temperature through the NR compounds had been studied. Results indicate that CV system compound showed better tensile properties before ageing but poorer ageing resistance compare to EV system compound. CV system also shown poor swelling resistance and low crosslink density before ageing. The swelling properties and crosslink density of EV system compound remained with increased period of ageing. Diffusion coefficient, D and permeability coefficient, P values of CV system compound were higher than EV system compound before ageing. EV system compound showed similar diffusion coefficient, D and permeability coefficient, P values after ageing while permeability behavior of CV system compound vary with ageing time. It can be concluded that the crosslink density plays role to determine permeability behavior of elastomers.

(Keywords: crosslinking agent, sulfur, *in situ* vulcanization, impact strength)

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Design of Thermal Management Mould for Computer Mouse

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In the injection moulding process, the cooling time of the product consists of nearly 40-50 % of the cycle time. In addition, the cooling time affects the dimensional accuracy, the post deformation and the microstructures of the moulded product. Hence, the injection moulding industries have been actively undertaken in effort to reduce the cooling time and to develop the uniform cooling technologies. The direct metal rapid tooling & manufacturing technologies, in which the metal product are manufactured from the layer-by-layer stacking of the molten and sintered metal powder, allows various types of effective cooling methodology in the mould. The objective of this research work is to design the thermal management mould for computer mouse using the finite element analyses. Thermal management mould with three different materials was designed to induce a rapid cooling of the mould of the computer mouse. The mould layer with injection tool steel and the heat sink layer with a superior thermal conductivity to the mould layer as well as the mid-layer with the mean thermal expansion coefficient of the mould and the heat sink layers constituted the thermal management mould. The materials of the mould, mid and heat sink layers were chosen as P21, Monel400 and Ampcoloy940, respectively. The influence of geometrical design of the thermal management mould on the cooling characteristics, the thermal stress distribution in the vicinity of the mid-layer and the maximum deflection was investigated via the heat transfer, thermal stress and the stress analyses. From the results of the numerical analyses, a proper design of the thermal management mould was obtained. In order to verify the efficiency of the designed mould, injection moulding experiments were performed. The thermal management mould was manufactured from the hybrid rapid manufacturing technology combining the laser-aided direct metal tooling (DMT, Inssteck Inc.) with the machining process. The results of the injection mould experiments showed that the cooling time can be shortened from 10 seconds to 7 seconds.

Keywords: Thermal management mould, Hybrid rapid manufacturing technology, Design of Injection mould, Computer mouse