Rubber/Gum/Resin

NPARR, 8(2), 2017-392  Reinforcement of natural rubber with bacterial cellulose via a latex aqueous microdispersion process

Natural rubber (NR) composites were reinforced with bacterial cellulose (BC) to improve mechanical and physical properties. The natural rubber bacterial cellulose (NRBC) composite films were prepared via a latex aqueous microdispersion process by a thorough mixing of BC slurry with natural rubber latex (NRL). The structural morphology and chemical and physical properties of NRBC composites were investigated. The hydrophilicity, opacity, and crystallinity of the NRBC composites were significantly enhanced because of the added BC. By loading BC at 80 wt.%, the mechanical properties, such as Young's modulus and tensile strength, were 4,128.4 MPa and 75.1 MPa, respectively, which were approximately 2,580 times and 94 times those of pure NR films, respectively, whereas the elongation at break of was decreased to 0.04 of that of the NR film. Because of its high mechanical strength and thermal stability, the NRBC composites have potential uses as high mechanical strength rubber-based products and bioelastic packaging in many applications [Phomrak, S*, and Phisalaphong, M (Chemical Engineering Research Unit for Value Adding of Bioresources, Department of Chemical Engineering, Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand) Journal of Nanomaterials, 2017, 2017, 1-9].

NPARR, 8(2), 2017-393  Biologically sustainable rubber resin and rubber-filler promoter: A precursor study

Enthused by the ever growing demand for sustainable and green based materials in responding to applications based on macromolecules, an attempt was made in seeking a bio-resin (Terpene). Herein, we report the functionalization of bio-resin with natural rubber (NR) to produce new sustainable and greener functional polymer. Bio-resin functionalized NR was prepared by melt mixing using di (2-tert butyl peroxo isopropyl) benzene initiator. Structure elucidation of the bio-resin functionalized NR was established by proton nuclear magnetic resonance and Fourier transform infrared spectroscopy, respectively. Bio-resin functionalized NR facilitates the augmented interaction with highly dispersible silica. Amended state of highly dispersible silica dispersion has been achieved in the absence of toxic process oil, expensive silane coupling agent and conventionally used zinc oxide. Remarkable improvement in overall properties corroborated with various meticulous characterization including nanoindentation, rheological, physico-mechanical and small angle X-ray scattering using Becauge model, etc. The dynamic mechanical properties of the greener polymer demonstrated low rolling resistance coupled with high traction. More decisively, the macromolecule system toned up sparingly in the presence of the bio-resin. Our contribution facilitates a novel avenue to develop sustainable high-performance elastomeric macromolecule [Manoharan, P. and Naskar, K* (Rubber Technology Centre Indian Institute of Technology Kharagpur 721302 India) Polymers for Advanced Technologies, 2017, doi: 10.1002/pat.4034].

NPARR, 8(2), 2017-394  Softwood-lignin/natural rubber composites containing novel plasticizing agent: Preparation and characterization

Composite materials based on natural rubber were obtained by using glycerolysate (decomposition product of polyurethane) as a novel plasticizer. In order to determine the effect of various lignin content, four different filler amounts were used, namely, 5 phr (parts per 100 parts of natural rubber) of lignin (WLI5G), 10 phr (WLI10G), 20 phr (WLI20G), and 40 phr (WLI40G). The reference specimen without lignin (WLI0G) was also prepared. The resulting vulcanizates were analyzed by Fourier Transform
Infrared Spectroscopy (FTIR) to determine the chemical interaction between the lignin powder and the natural rubber chain. Scanning Electron Microscopy (SEM) of the cross-sections of the obtained materials was carried out to determine the adhesion between lignin and rubber. The results of dynamic mechanical analysis (DMA) and thermogravimetric analysis (TGA) showed that the samples containing 5 and 10 phr of lignin had the best thermal properties. Also, the measured mechanical properties confirmed these findings [Datta, J*, Parcheta, P. and Surówka, J (Gdańsk University of Technology, Faculty of Chemistry, Department of Polymers Technology, G. Narutowicza Str. 11/12, Gdańsk, Poland) *Industrial Crops and Products, 2017, 95, 675-685].

NPARR, 8(2), 2017-395 An improved shear lag model for predicting stress distribution in hybrid fiber reinforced rubber composites

An improved micromechanical shear lag model, which considers the interphase and bonded fiber end, is developed to investigate the load-carrying characteristics and stress profiles in hybrid aramid/sepiolite fiber reinforced rubber composites. The properties of the equivalent matrix, which is combination of sepiolite fiber and rubber matrix, are determined by Mori-Tanaka method. The axial and shear stresses at the fiber end are resolved by the imaginary fiber technique. The results obtained from the improved model show the tensile stress has a maximal at the real fiber center and the interfacial shear stress has a maximal at the end of the real fiber. Comparing with the results from Tsai’s model, the improved model has a better agreement with the numerical simulation results. The effects of the imaginary fiber length on the stress transfer are analyzed and the results show that the effects can be ignored when the imaginary fiber length is greater than twice of the fiber radius. The effects of interphase modulus and thickness on the maximal axial and shear stresses are discussed. The results show that the interphase modulus and thickness of about 106.3 MPa and 0.2 μm are optimal to prevent interfacial debonding and improve the strength of hybrid fiber reinforced rubber composites [Zhang, B*, Yu, X. and Gu, B (School of Mechanical Engineering, Changshu Institute of Technology, Changshu, China) *Fibers and Polymers, 2017, 18(2), 349-356].

NPARR, 8(2), 2017-396 Structural, thermal and physico-chemical properties of high density polyethylene/natural rubber/modified cassava starch blends

The utilization of cassava starch as one of the components in high density polyethylene (HDPE)/natural rubber (NR) blends were investigated. The true challenge in producing new materials based on natural resources is to design materials that could level the mechanical properties of existing conventional polymers. In this study, we have focused on characterizing the HDPE/NR blends incorporated with cassava starch in the form of granulates (native and silanized) as well as plasticized starch. Cassava starch acted as a biodegradation component in the HDPE/NR blends and the incorporation of cassava starch reduced thermal stability and the degree of crystallinity in general. Several series of cassava starch modifications were performed in order to improve the final properties of the blends. Cassava starch was treated with a silane coupling agent, and proved to be effective in improving tensile strength. The better dimensional stability and compatibility between the blend phases were obtained in the silane-treated cassava starch, as observed in the dynamic mechanical analysis results. Cassava starch was also converted into a plasticized form (TPS), and from the results, the degree of TPS adhesion at the inter-phase of the HDPE/NR-TPS blend was clearly improved, as indicated in the morphology study. Through the comparison of thermal degradation results, the HDPE/NR/TPS blends proved to be superior to the HDPE/NR/particulate starch counterparts [Kahar,
The adhesion properties of magnesium oxide filled epoxidized natural rubber (ENR 25)/acrylonitrile-butadiene rubber (NBR) blend adhesives were studied using petro resin and gum rosin as tackifiers. Toluene was used as the solvent throughout the experiment. Five different loadings, i.e. 10, 20, 30, 40 and 50 phr magnesium oxide was used in the adhesive formulation. The SHEEN hand coater was used to coat the adhesive on polyethylene terephthalate at 30 and 120 µm coating thickness. The tack, peel strength and shear strength were determined by a Lloyd adhesion tester operating at 30 cm min⁻¹. Results show that all the adhesion properties of the ENR 25/NBR adhesives show a maximum value at 10 phr filler loading. Loop tack and peel strength pass through a maximum, an observation which is associated to the optimum wettability of adhesive on the substrate. For the shear test, maximum shear strength occurs due to the optimum cohesive strength of the adhesive. Results also show that all petro resin based adhesives have higher adhesion properties than gum rosin based adhesive. In all cases, the adhesion properties of adhesives also increase with increasing coating thickness [Soo, K.W., Azahari, B. and Poh, B.T* (School of Industrial Technology, Universiti Sains Malaysia, Penang, Malaysia) Journal of Polymers and the Environment, 2016, 24(4), 334-342].

Lignin and lignin derivatives biopolymers have several properties, such as high thermal stability, antioxidant, biodegradability, antimicrobial actions, adhesive properties, etc., and thus they can be extensively used in wide range of areas. Although human history mostly depend on the biopolymers, however derivatives of lignin such as sulfonate, phenolic, organosolv, Kraft and sodium sulfonate lignin have good mechanical and physicochemical properties. Well-designed materials such as coatings and paints, manufacturing of plastics and resins, for rubber packaging, for fuel production etc., can be obtained by the functionalizations of chemically modified lignin. Considering multi purposes properties of the lignin and lignin derivatives and extensive industrial applications of derivatives, this review sheds a light on lignin derivatives based materials with their prospective applications. All the technical scientific issues have been addressed highlighting the recent advancement [Naseem, A., Tabasum, S*, Zia, K.M., Zuber, M., Ali, M. and Noreen, A (Institute of Chemistry, Government College University, Faisalabad, Pakistan) International Journal of Biological Macromolecules, 2016, 93, 296-313].

Viscosity, loop tack, peel strength, and shear strength of epoxidized natural rubber (ENR 50)/acrylonitrile-butadiene rubber (NBR)–based pressure-sensitive adhesive were studied in the presence of zinc oxide. The zinc oxide concentration was varied from 10 to 50 parts by weight per hundred parts of rubber (phr). Coumarone–indene resin with loading of 40 phr was chosen as the tackifier resin. Toluene and polyethylene terephthalate were used as the solvent and coating substrate, respectively, throughout the experiment. The adhesive was coated on the substrate by using a SHEEN hand coater. Viscosity of the adhesive was determined by a Brookfield Viscometer, whereas the loop tack, peel strength, and shear strength were measured by a Lloyd Adhesion Tester operating
at 30 cm/min. Results indicate that viscosity increases with zinc oxide concentration owing to the concentration effect. Loop tack and peel strength pass through a maximum value at 20 phr of zinc oxide concentration. This observation is associated with the effect of varying degrees of wettability of the adhesive on the substrate. Shear strength, however, increases steadily with increasing zinc oxide loading owing to the steady increase in cohesive strength. In all cases, the adhesion properties of adhesives increase with increasing coating thicknesses [Poh, B.T*. and Suid, N.H (School of Industrial Technology, Universiti Sains Malaysia, Penang, Malaysia) Journal of Vinyl and Additive Technology, 2016, 22(4), 410-414].