SESSION 7

BIOCOMPOSITE TECHNOLOGY

INVITED SPEAKER

Chitosan Nanofiber and Cellulose Nanofiber Composites for Food Packaging Application

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Chitosan, the second most abundant materials after cellulose on earth, is a green, biodegradable and renewable material. It has been used for drug delivery, artificial skin, wound-covering, medical applications, contact lens, water filtration, and food packaging. This paper reports extraction of chitosan nanofibers and its application for food packaging. The chitosan nanofiber (CTNF) was isolated by a physical method, so called aqueous counter collision (ACC) and studied for food packaging composites. To further improve the physical properties of the food packaging material, cellulose nanofiber (CNF) was blended with CTNF so as to improve not only its biocompatibility and biodegradability, but also its physical properties. This presentation explains all about nanofiber isolations of cellulose and chitosan by means of chemical method, so called TEMPO oxidation and physical method, ACC. Cellulose and chitosan are recognized as the first and the second largest polymers available on earth, respectively. Thus, using both materials for food packaging offers a lot of benefits in terms of environmental protection and sustainable resources. In addition, chitosan is well-known for antibacterial properties, food preservation, and good antioxidant activity. The combination of CNF-CTNF composite could enhance the function of food packaging. The thermal stability, crystallinity, viscosity, antioxidant, and tensile strength of CNF-CTNF composites were investigated with the thermal analyzer, X-ray diffraction, Brookfield viscometer, antioxidant test, and tensile test, respectively. Tensile strength of CNF-CTNF composites shows great improvement and retained the usual Young's modulus. The antioxidant properties of the composites were investigated using ABTS. The composites show better antioxidant activity than pure CNF.

Keywords: Chitosan, cellulose, nanofiber, composite, food packaging

ID: O23

The Effect of the Two Hybrid Composite Configurations Based on Jute and Glass Fibers on Mechanical Properties: Inter-Layer and Intra-Layer

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Nowadays, natural plants preoccupied a large place in different fields especially as reinforcement in composite materials. This is due to their advantageous virtues such as high stiffness, lower density, low cost, environment respecting and availability. However, they represent some drawbacks as the incompatibility with the polymer and low moisture resistance. In this work, the polyester resin is used as the matrix to assemble the same weight rate of jute fibers (Corchorus capsularis) and glass fibers in two configurations of hybridization: inter-layer (layer by layer) and intra-layer (yarn by yarn). The hand layup technique is used to manufacture different composites which they have assessed their moisture resistance and mechanical properties. The experimental flexion modulus of the two laminated configurations is compared with theoretical result found from the mixing law and homogenization technique. The results show the effect of hybridization and that the configuration of interlayer jute and glass fiber represent a configuration with low moisture resistance than the other cited configuration. The theoretical mechanical results of elaborated composites are close to empiric outcomes. The slight difference is due to the considered assumptions.

Keywords: Natural fibers, synthetic fibers, hybrid composite, inter-layer and intra-layer configuration, hand layup technique, mechanical properties, moisture resistance, Hybridization effect.

ID: O24

Injection Molding of Short Natural Fiber Based Biocomposites: Prediction of the Mold Filling Phase, fibers Orientation and Mechanical Properties

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Injection molding is one of the most widely used polymer-processing methods. Indeed, thermoplastics coupled with short natural fibers, as reinforcement, were shown to substantially improve their mechanical performance without compromising their process ability. However, the properties of the final products are strongly affected by the fiber orientation field set up during processing. This flow-induced fiber orientation results in a preferential short fibers orientation which may be influenced by many factors. The flow of fiber filled thermoplastics in the molten state is modified by the presence of fibers and reciprocally the fiber motion and rotation is affected by the flow, so the relations between them can be studied by the study of the material rheological properties. Basing on that, the first step was to study the flow by developing a three-dimensional model for the non-isothermal and non-Newtonian mold filling prediction. Then, the Jeffery equation established for the fiber orientation prediction only in the case of Newtonian and dilute suspension, can lead to important prediction errors because the fiber orientation field is not taken into account to determining the flow dynamics or to calculating the material viscosity. So, the aim of our works is to attempt a predictive method by using coupled solutions between the fiber orientation and the viscosity. In fact, for an arbitrary plane flow, the flow field equation developed basing on the Navier–Stokes equations is introduced to the fiber orientation equation established by Jeffery, resulting in an equation that relates the fiber orientation angle to the flow field, the fiber aspect ratio and the mold shape, in the case of non-isothermal and non-Newtonian mold filling. Finally, this precocious fiber orientation prediction will allow the material mechanical properties deduction. Thus, for a complete injection molding study, a self-consistent approach was developed for the composite properties prediction while taking into account the effect of reinforcement content and orientation. To conclude, this work makes it possible to attempt a precise prediction of the final product properties via developing qualitative models for the flow inducing fiber orientation prediction, by knowing only the composites rheological properties and the mold size.

Keywords: Injection molding, composites, Mechanical properties; Fiber orientation; Flow field; Rheological properties

ID: O25

Potential of Mixed Cocopeat Fibres and Wood Waste Factory Particleboard: A Preliminary Study

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Mixed particleboard made from cocopeat fibres and wood waste factory was evaluated in this preliminary study. The particleboard was produced based on a target density of 700 g/cm^3 with 10 % resin level. This study aimed to test the compatibility of these two types of raw material when bonded with natural rubber latex and Urea-formaldehyde (UF) used as a control sample. The 100% cocopeat fibres, 70:30 wood waste: cocopeat and 100% wood waste factory were used as a parameter in this study. The physical and mechanical properties were done and evaluated according to JIS A 5908: 2008 for type 8 in particleboard manufacturing. As expected, all the samples bonded with commercial resin had shown excellent results as compared to panels bonded with natural rubber latex. The boards made from the mixed of 70:30 wood waste: cocopeat fibres ratio bonded with UF had achieved 5.74%, 14.96%, 117.77%, 221.39 N/mm^2, 3.28 N/mm^2 and 0.04 N/mm^2 for moisture content (MC), thickness swelling (TS), water absorption (WA), modulus of elasticity (MOE), modulus of rupture (MOR) and internal bonding (IB), respectively. However, none of these samples was met the minimum requirement of board strength as stated in the JIS standard. All the samples bonded with natural rubber latex did not show any advantages except obtained the highest results in MOR analysis (4.39 N/mm^2) for boards made from 100% cocopeat fibres and highest MOE (366.49 N/mm^2) value for boards made from 100% wood waste. From the findings, it can be concluded that wood waste factory can be used as part of raw materials in particleboard manufacturing. However, the cocopeat fibres without fine dust in this study can be suggested as a filler in particleboard fabrication. The usage of free-formaldehyde adhesive such as natural rubber latex still needs further modification by mixing with synthetic resin and additives for future development.

Keywords: Cocopeat fibres, wood waste, natural rubber latex, particleboard

ID: O26

Dimensional Stability and Mechanical Properties of Epoxy/Nano-Silica from Rice Husk Cross-Linked with Tetraethoxysilane

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The natural fibre reinforced plastic desperately to find a way to solve the hydrophilic nature of natural fibre when it is mixed with synthetic polymer or plastic. The hydrophilic property is known not only to absorb the surrounding moisture which can creates the dimensional movement of the composite; but the moisture entraps in the fibre cell wall also give opportunity for decay and insect to utilise the food sources and further decaying the composite. Efforts to solve the hydrophilic property of natural fibre mix with polymer or plastic, many researchers has modify the natural fibre with chemical such as acetic anhydride and thermal such as heat treatment. Although both treatment successfully eliminates the moisture adsorption and water absorption, other important properties such as mechanical properties are greatly reduced. In this study, the epoxy resin was reinforced with nano-silica from rice husk aimed to solve the hydrophobic property of natural fibre. The epoxy resin was mixed with 10 % nano-silica and 0%, 1%, 2% and 3 % of tetraethoxysilane was added to cross link the epoxy with nano-silica. The water absorption and thickness swelling were measured after 21 days of submerged period (first cycle) and it was then repeated for another 2 cycles in according to the MS standard. The same standard was applied for the mechanical properties. The results showed that all the parameters were significantly different with the untreated and the percent of tetraethoxysilane. The water absorption was lowest with neat epoxy for all cycles, but composite with 2% tetraethoxysilane had the lowest thickness swelling for first cycle and second cycle. The thickness swelling was not significantly different with types of composite after third cycle. The neat epoxy composite had the highest mechanical properties compared to other composite with tetraethoxysilane.

Keywords: Epoxy, composite, silica, resin, tetraethoxysilane, rice husk