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This paper presents electrical and mechanical properties of compound consisting of acrylonitrile butadiene styrene (ABS) resin mixed with CFRP pieces. CFRP pieces made by crushing CFRP wastes are utilized in this material. Eight kinds of compounds with different weight fraction and size of CFRP pieces are prepared. Firstly, electrical impedance of the compounds is measured as a function of frequency. Electromagnetic shield effect in the frequency range between 60 MHz and 1.2 GHz is also investigated and compared with that of a CFRP laminate. Secondly, mechanical properties such as tensile and flexural strength are measured. Finally, the polished surface and fracture surfaces of the specimens are microscopically observed to investigate the effect of orientation and distribution of CFRP pieces on mechanical and electrical properties. Resistivity decreases and shield effect increases with CFRP content. Mechanical properties such as strength and modulus are improved almost linearly with an increase in CFRP content although strength saturates at CFRP content of 50%. Carbon fibers are not coated by epoxy resin and dispersed individually in ABS resin whilst some fiber bundles coming from the original CFRP pieces are included. For practical application to electromagnetic shield, other kinds of conductive filler should be mixed with CFRP pieces to obtain better conductivity.

PMC-19: Evaluation of Damage and Stress of Woven Carbon Fabric Laminates with Piezoelectric Particulate Epoxy Using Electric Properties
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The piezoelectric specimens laminated with woven carbon fabric and poled lead zirconate titanate (PZT) particulate epoxy were prepared to suffer repeated loading tests and the relationship between loading and piezoelectric signals was investigated. The possible mechanism of the measured signal generation in the piezoelectric specimens is variation in the capacitance of epoxy layers rather than in the polarization of PZT particles. The peak interval in the piezoelectric signal waveforms was deeply related to the applied tensile stress and the peak intensity tended to increase with loading cycles.

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Carbonizing was proposed as one of the material recycling methods to treat waste fiber reinforced plastic (FRP), but it has not been researched yet how much influence this method affects to the natural environment. The purpose of this study is to investigate the recycling effect of Carbonizing method for waste-FRP quantitatively by Life Cycle Assessment (LCA). But LCA has not been fully established as the technique for this evaluation; therefore by comparing Carbonizing system with ordinary disposal one, the recycling effect was quantitatively analyzed. Environmental burdens of equivalent material through Carbonizing method was also included in ordinary disposal system in order to compare more precisely in view of their "functional unit" and "system boundaries." Based on this method, a case study was done on the CFRP hood of a car for disposal. As a result, Carbonizing system exhausts much less CO₂ emissions than disposal system, which indicates that Carbonizing method could be superior to disposal method on natural environment.

PMC-21: Computer Simulation and Design of Deep Drawing Process for Laminated Composites
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The anisotropic nature of laminated composites creates a unique opportunity and also a great challenge for tailoring their behavior during the forming processes according to the design requirements. In this work, design and simulation of a deep drawing process for fiber-reinforced laminated composites were conducted by using finite element analysis. The effects of the fiber orientation and stacking order on the deep drawing process were investigated based on the basic understanding of forming process of the isotropic aluminum alloy (Al-1100) and laminated composite material (Girlon RVZ-15H nylon/glass). A three dimensional finite element model incorporating layered structural laminates with various fiber orientations was developed. The load-stroke relationship, changes in thickness, and stress-strain distribution were investigated and compared for both aluminum alloy and laminated composites of [0]/[0], [0/90°] and [±45°/0/90°], which can be employed for detailed design and process optimization.

PMC-22: On the Wavy Crack Propagation Behavior in Internally PressurizedBrittle Tube
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It is well-known that when a high pressure gas tube fractures, a crack often propagates sinusoidally instead of running straight axially perpendicular to the hoop stress direction. In this study, fracture experiments were conducted using glass tubes by pressurizing internally with high pressure water and the paths of the crack propagations were observed. It has been clarified that a wavy crack often appears even in a brittle tube like glass pressurized internally by liquid (water) and that especially when the ratio of the thickness to the external diameter of a glass tube is very small, a wavy crack is likely to be running. As the results of the experiments with changing the size of glass tube, it has been clarified that the shapes of the wavy cracks are approximately similar to one another. The relation between the wavelength λ, the amplitude A of the wavy cracks and the external diameter D of the glass tubes has been obtained as λ = 4D and A = 0.4D. Furthermore, the crack propagation was monitored by a high-speed video camera system and as the result, it has been shown that a crack moves sinusoidally only when the crack propagation velocity is negligible (200 m/s at most) comparing with the elastic wave velocity of glass and that the wavy crack never appears when the crack velocity is large. Therefore, it can be concluded that the mechanism of the wavy crack propagation is not due to the dynamic effect resulting from the rapid crack propagation.

16:00 p.m. - 18:00 p.m.
MEP-II: MECHANICAL PROCECING

MEP-05: Preliminary Investigation of Laser Assisted Mechanical Micromachining
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Mechanical micromachining is capable of generating three-dimensional free-form surfaces to sub-micron level precision and micron level accuracies in a wide range of materials including common engineering alloys. However, at micro/nano length scales the cutting tool stiffness and strength limit the utility of mechanical micromachining methods. This paper is focused on investigation of methods to overcome these limitations. The basic concept involves creating highly localized thermal softening of the material by focusing a solid-state fiber laser beam just in front of a miniature cutting tool. A machine has been designed and fabricated to implement a novel laser assisted mechanical micromachining (LAMM) process. Preliminary experiments are designed to investigate the effect of laser variables (spot size and laser power) and cutting con-