STRUCTURALLY GRADIENT IMPACT RESISTANT ICPC NANO-COMPOSITE FOAMS FOR AUTOMOTIVE APPLICATIONS

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Polymer nanocomposite (PMC) foams represent an interesting class of lightweight functional materials for use in hydrogen storage, chemical and mechanical sensing, EMI shielding, etc[1]. Nanoparticles (NPs) can significantly improve their strength and stiffness at the expense of enhanced density[2]. The literature suggests that strength and stiffness improvements– after accounting for density increase – are typically modest for thermoplastic foams. However, major improvements are possible for reactively generated foams, especially flexible polyurethane foams and other polymers with their service temperature above their T_g. Structural foams for automotive applications require also enhanced impact resistance. With their hierarchical architectures incorporating gradients in composition, structure and orientation, biological systems have evolved optimized structures and properties[3]. Such gradients, together with multiple length-scale hierarchical structures, represent the two prime characteristics to be translated into engineering design. These architectures offer functionally graded mechanical properties, i.e., the local stiffness and strength that decrease monotonically from the surface towards the interior, with a fracture resistance that varies inversely due to enhanced extrinsic toughening from continuous crack deflection. This helps suppress the elastic/plastic deformation and damage near the surface of the material and accommodate the stress and dissipate mechanical energy towards its interior, making any cracking in the inward direction increasingly more difficult. As such, the contact damage resistance of materials is enhanced to provide greater protection to surface penetration.

In this contribution we report on gradient PNC foams consisting of PP impact copolymers containing small volume fractions of NPs with varying shape and strength of interfacial attraction. Effects the various NPs insert on the ICPP foam morphology (cell size, shape and connectivity), density and wall material properties will be discussed. Fundamental design principles controlling balance of stiffness, strength and impact resistance of gradient ICPP nanocomposite foams intended for automotive applications will be outlined.

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