Fabrication and Self-assembly of Nanoparticles for Heterogeneous Structures

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Nanoparticles are important building blocks in several applications of Nanotechnology. Beside, the enormous increase of their surface area, the high surface to volume ratio of the nanoparticles results in extraordinary high reactivity, and unusual physical properties (optical, magnetic, etc) Dispersed nanoparticles are used in several important applications, e g., catalysis, biomedical applications, etc

Nanostructured materials, prepared by consolidating nanoparticles with a very high density of grain boundary, have shown to have dramatically improved mechanical and physical properties A recent promising development is the fabrication of systems with nanometer features using self-assembly Nanoparticles can be used for the fabrication of high hierarchical artificial structures through self-assembly The nanoparticles can be made of composites with controlled structure Nanoparticles can be fabricated with different core and shell structures, e g , metallic core and oxide shell or the reverse The selection of the composition and structure of the shell layer allows different chemistry to be conducted at the surfaces, e.g , inducing biocompatibility, enhanced electrical conductivity, or reactivity By a proper combination of the chemistry at the surface of the particles and substrate, it is possible to achieve a spontaneous self-positional organisation of the particles on the substrate to form stable 2D and 3D structures In this talk, a presentation of some of our recent results on the fabrication and self-assembly of composite nanoparticles will be presented together with some examples of applications

Composite Foams for Enhanced Toughness

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Polymer foams are among the lowest density engineering materials available and are commonly used as packing materials to absorb impact energy They also exhibit good insulating properties, although the strength and stiffness levels are low compared with other structural materials Several natural materials are also porous (e g , wood and bone), and are highly efficient materials in terms of performance per unit weight However, man-made foams rarely approach the performance levels of natural porous materials, and most foams are not suitable for structural applications When used for structural purposes, foams are typically laminated between high-strength skins in assemblies called sandwich structures The function of the foam core is to transmit shear loads between the skins, and the performance of the sandwich structure is enhanced by improvements in core stiffness and strength

Recent work at USC has focused on strategies to enhance the toughness and overall mechanical performance of polymer foams for use in lightweight sandwich structures Both mechanical and chemical approaches have been employed with reasonable success Fiber reinforcement, though difficult from a processing perspective, can lead to substantial enhancements in toughness and strength, while reducing friability Chemical modifications are also challenging from a processing perspective, but can produce similar enhancements in performance Efforts to enhance performance of phenolic foam and PVC foam through fiber reinforcement and chemical modification will be presented