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Smart Composite Structures and Their Applications in Aerospace Engineering

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Abstract: Smart materials can be defined as the materials that have the capability of sensing and reacting to environmental conditions or stimuli. In recent years, a wide range of novel smart materials have been developed, and the applications of smart materials now cover various important fields including aerospace, automobile, telecommunications, and so forth. This talk mainly focuses on recent progresses of Smart Soft Polymer (SSP) and SSP based multifunctional nanocomposites, including Shape Memory Polymer (SMP) and Electro-Active Polymer (EAP), as well as their applications in aerospace engineering. This seminar also summarizes the recent advances in synthesis of novel epoxy-based SMP, styrene-based SMP, cyanate ester-based SMP, polyurethane-based SMP, design and characterization of SMP composites (SMPCs) filled with nickel chains, short carbon fiber, carbon nanotube chains, and carbon nanopaper. The SMP driven approaches, including heat, electric, light, magnetic field and solvent have been introduced, and a detailed overview of the recent progress of SMPCs used in the space deployable structures (i.e. SMPC hinge and truss) is also presented. To guide the fabrication of high performance dielectric elastomer (DE) actuators, the constitutive model, electromechanical stability, snap-through stability and failure of DE and its composite are investigated. The stress-strain relationship and the electro-induced deformation of carbon nanotube-based DE composites are studied. The rolled, folded, inflated and stacked actuators of DE have been fabricated and their properties are also investigated. The energy harvest device and Braille display are fabricated based on the stacked actuators, and their performance is demonstrated.This report also presents the speaker's recent work on active vibration control of aerospace structures (i.e. solar array, vertical fin) using Macro Fiber Composites (MFC). Expecting to extend the range of their development and applications, smart composites and structures available in the related researches are also discussed at the end of this talk.