BASIC RESEARCH THRUSTS IN MULTIFUNCTIONAL MATERIALS AND STRUCTURES

by

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Abstract

Two major criteria governing the development of new aerospace structures have been: (a) the achievement of maximum load-carrying capability per unit weight/volume and (b) the incorporation of a variety of functional properties dictated by the system requirements (e.g. sensing, self-healing for crack mitigation, lightening protection, thermal management, built-in external communication ability, power harvesting and storage, etc.) with minimum weight penalty. Traditionally, these two issues are addressed separately, resulting in incremental improvements in mono-functional materials that only carry mechanical load or only provide specific functional property. However, dramatic improvements in system-level efficiency can be achieved by: (1) developing "multifunctional" materials that inherently possess the capacity to simultaneously meet the requirements for specific functionality as well as mechanical load carrying capability and (2) designing "multifunctional" load-bearing structures with integrated functional properties.

The following key issues need to be examined for this endeavor:

- Structural integration of electronic devices
- Combination of load-carrying capabilities with functional requirements
- Development of new adaptive, sensory and active materials
- Revolutionary concept of "autonomic" structures which sense, diagnose and respond for adjustment
- Hybridization of materials and lay-up for complex requirements
- Physics-based multi-scale modeling
- Neural network and information science aspects for the control of multifunctional structures
- Design for manufacture