

1. **Research Title: Understanding onset of damage in multifunctional composite**
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**

Materials Science and Engineering, Chemical Engineering, Chemistry, or Physics (MS or PhD level)
4. **Objectives: Understanding onset of damage in multifunctional composite, nanoscale strain mapping, underlying processing-structure-property relationship by combining both experimental and computational approaches.**
5. **Description:** Efficient materials design and development of tools for their damage prediction are crucial for multifunctional composites. Biomimetic design has opened up avenues for achieving extraordinary combinations of toughness and strength, similar to natural composites, although natural composites still surpass these properties. Key challenges include lack of understanding of the failure mechanisms in such composites and the influence of size, shape, and orientation of the nanofiller on toughening. There are still open questions about chemical structure and morphology around the interphase region and its influence on the mechanics. Overcoming these challenges requires careful design and a multidisciplinary approach combining synthesis, processing, characterization (across scales), and multi-scale modeling. We are interested in understanding the failure mode from the nano- to higher scales, and the underlying processing-structure-property relationship. Key interests include the biomimetic design of hierarchical structures; elucidating the fundamental principles of the underlying fracture mechanism based on chemistry and shape / size / distribution of the nanofillers; investigating corresponding electrical and optical properties; and establishing techniques to predict failure using molecular and mesoscale mechanics modeling. Techniques include bulk and surface spectroscopy, high-resolution X-ray micro-computed tomography, nanoscale chemical / physical / mechanical mapping, atomic force microscopy, electron microscopy, in-situ testing, and multi-scale modeling.
6. **Research Classification/Restrictions:** Unrestricted
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided



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AFIT (only)

USAFA (only)

If you are submitting a topic for the USAFA, indicate if you are also interested in sponsoring a USAF Cadet in summer 2015 (Average cost for USAF Cadet for 33 days is \$5000)

Yes

No