Announcing the Final Examination of Daniela Fugon-Dessources for the degree of Master of Science

Time & Location: March 24, 2014 at 7:00 AM in ENG-1 307-D
Title: Piezospectroscopic Calibration of Alumina-Nanocomposites for the Development of Stress-Sensing Structures

Alpha-alumina is known to exhibit piezospectroscopic properties through characteristic spectral emissions or R-lines that shift with an applied stress. Recent work has shown that the photo-luminescent (PL) properties can be observed when polymers with embedded alumina nanoparticles are subjected to laser excitation, indicating the potential to develop stress-sensing materials. While the piezospectroscopic properties of alumina-epoxy nanocomposites have been successfully demonstrated in compression, they have not been calibrated for tension. In this study, the photo-luminescent response of variable volume fraction alumina-epoxy composites was determined under tensile conditions. It was expected that increasing the volume fraction of alumina nanoparticles would increase the sensitivity of the particles PL emission shift to an applied tensile stress. Three tensile alumina-epoxy specimens of 20%, 30%, and 34% volume fractions were manufactured and tested under static loads up to failure. The results of this experiment provide the piezospectroscopic (PS) coefficients for the calibration of bulk alumina nanocomposites in tension. A linear region was identified in the photo-luminescent response of the nanocomposite to the applied tensile load. The PS coefficient of this linear region increased as the volume fraction of the nanocomposite increased. To demonstrate the application of a typical aerospace structural composite with stress sensing capabilities, the alumina nanoparticles were integrated into the manufacturing of a carbon-fiber composite specimen and mechanically tested in tension with simultaneous photo-luminescent data collection. The results established that the integrated alumina nanoparticles were able to detect changes in stress through spectral shifts. The results of the bulk nanocomposite calibrations and the application of stress-sensing alumina nanoparticles in a carbon-fiber composite provide critical information that will advance the development of this novel stress-sensing method.

Major: Mechanical Engineering

Educational Career:
Bachelor's of Aerospace Engineering, BS, 2012, North Carolina State University

Committee in Charge:
Dr. Seetha Raghavan, Chair, Mechanical and Aerospace Engineering
Jihua Gou, Mechanical and Aerospace Engineering
Nina Orlovskaya, Mechanical and Aerospace Engineering

Approved for distribution by Dr. Seetha Raghavan, Committee Chair, on March 3, 2014.

The public is welcome to attend.