Carbon nanofibers (CNFs) used as nano-scale reinforcement have been extensively studied since they are capable of improving the physical and mechanical properties of conventional fiber reinforced polymer composites. However, the properties of CNFs are far away from being fully utilized in the composites due to processing challenges including the dispersion of CNFs and the viscosity increase of polymer matrix. To overcome these issues, a unique approach was developed by making carbon nanopaper sheet through the filtration of well-dispersed carbon nanofibers under controlled processing conditions, and integrating carbon nanopaper sheets into composite laminates using autoclave process and resin transfer molding (RTM).

This research aims to fundamentally study the processing-structure-property-performance relationship of carbon nanopaper-based nanocomposites multifunctional applications: a) Vibrational damping. Carbon nanofibers with extremely high aspect ratios and low density present an ideal candidate as vibrational damping material; specifically, the large specific area and aspect ratio of carbon nanofibers promote significant interfacial friction between carbon nanofiber and polymer matrix, causing higher energy dissipation in the matrix. Polymer composites with the reinforcement of carbon nanofibers in the form of a paper sheet have shown significant vibration damping improvement with a damping ratio increase of 300% in the nanocomposites. b) Wear resistance. In response to the observed increase in toughness of the nanocomposites, tribological properties of the nanocomposite coated with carbon nanofiber/ceramic particles hybrid paper have been studied. Due to high strength and toughness, carbon nanofibers can act as microcrack reducer; additionally, the composites coated with such hybrid nanopaper of carbon nanofiber and ceramic particles shown an improvement of reducing coefficient of friction (COF) and wear rate. c) High electrical conductivity. A highly conductive coating material was developed and applied on the surface of the composites for the electromagnetic interference shielding and lightning strike protection. To increase the conductivity of the carbon nanofiber paper, carbon nanofibers were modified with nickel nanostrands. d) Electrical actuation of SMP composites. Compared with other methods of SMP actuation, the use of electricity to induce the shape-memory effect of SMP is desirable due to the controllability and effectiveness. The electrical conductivity of carbon fiber reinforced SMP composites can be significantly improved by incorporating CNFs and CNF paper into them. A vision-based system was designed to control the deflection angle of SMP composites to desired values. The funding support from National Science Foundation and FAA Center of Excellence for Commercial Space Transportation (FAA COE CST) is acknowledged.

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The public is welcome to attend.