NANOTUBE/FIBER MULTI-SCALE HYBRID COMPOSITES USING ELECTROPHORETIC DEPOSITION: PROCESSING, CHARACTERIZATION, AND SMART SENSING APPLICATIONS

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Carbon nanotubes are widely known to have unique physical and mechanical properties at the nanoscale. Because carbon nanotubes have diameters three orders of magnitude smaller than traditional advanced fibers used in structural composites there is unique opportunity to create multi-scale hybrid composite systems where reinforcement scales are combined. Our recent research has developed a highly efficient and industrially scalable electrophoretic deposition technique for nanoscale hybridization. The resulting composites show a hierarchical structure, where the structural fibers, which have diameters in micrometer range, are coated with carbon nanotubes having diameters around 10–20 nm. Microscopic characterization shows the integration of carbon nanotubes throughout the thickness of the fabric, where individual fibers are coated with carbon nanotubes. Within the composite, networks of carbon nanotubes span between adjacent fibers, and the resulting composites exhibit good electrical conductivity and considerable increases in the interlaminar shear strength, relative to fiber composites without integrated carbon nanotubes. We have demonstrated that conducting carbon nanotube networks formed in a polymer matrix can be utilized as highly-sensitive sensors for detecting the onset, nature and evolution of damage in advanced polymer-based fiber composites. The potential of carbon nanotubes for *in situ* monitoring of damage accumulation in fiber composites will be discussed and recent research on utilizing carbon nanotubes in monitoring of large-scale structures highlighted.

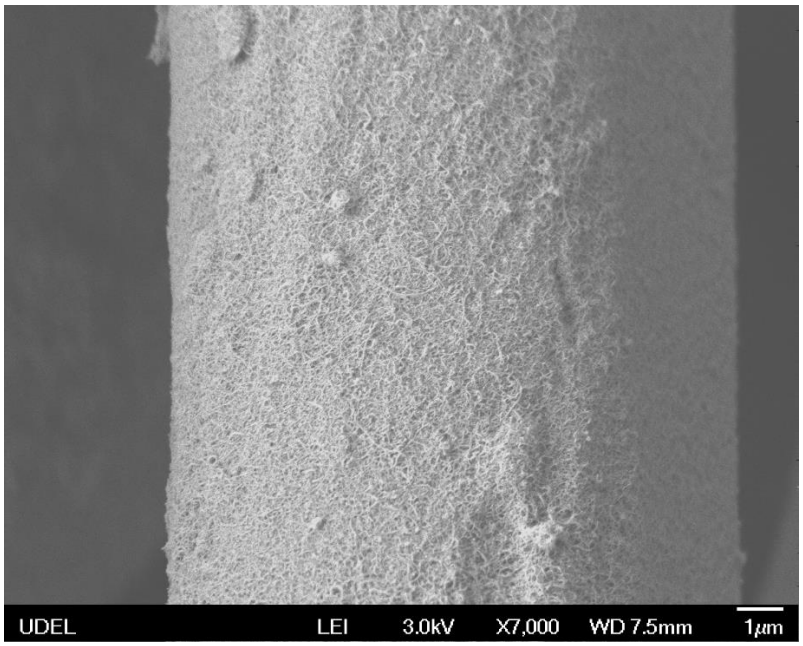

Figure 1 – SEM micrograph showing a highly uniform coating of carbon nanotubes formed using electrophoretic deposition on the surface of a traditional micron-sized advanced fiber.