Hierarchical composites for advanced multifunctional structures

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Abstract
The concept of hierarchical composites is based on the concept of coupling reinforcements of different scales following a biomimetic approach so as to establish maximum synergy between different scales. This synergy may guarantee the controlled engineering of the hierarchical phase so as to ensure optimal properties. These properties may target structural reinforcement, structural health monitoring, power storage and generation or even actuation. This approach poses multiple challenges among which is the actual preparation of the reinforcement. In this study, two different production methods, i) the Chemical Vapor Deposition (CCVD) and ii) a wet chemical impregnation technique were implemented. These multiscale reinforcements consist of structural carbon fibers (CFs) coated with carbon nanotubes (CNTs). Both production processes were optimized by adjusting crucial experimental parameters so as to finally obtain homogeneously deposited coatings on the surface of the fibers. The morphological characteristics of the hierarchical fibers were assessed via Scanning Electron Microscopy. Subsequently, the mechanical, interfacial and targeted functional properties of the hierarchical fibers were evaluated in order to provide a roadmap for the scale up to structural composites.