Polymer-embedded carbon nanotube yarns: Unveiling their piezoresistive response and sensitivity through parametric studies

Jandro L Abot[1*], Jude C. Anike[1], Akbar Pirmoz[1], Tannaz Tayyarian[1], Binita Saha[1], Abdulrahman Binfaris[1], Omar Rodriguez-Uicab[1] and Francis Avilés[1]

[1]Department of Mechanical Engineering, The Catholic University of America, Washington, DC, USA

[*]Corresponding Author: abot@cua.edu

The ability to measure strain using embedded micron-size sensors could revolutionize structural health monitoring and allow real-time monitoring of critical areas where direct access is not possible. Carbon nanotube (CNT) yarns are microscale and continuous assemblies of CNTs exhibiting a piezoresistive response that could be tapped for strain measurement. The piezoresistive response of free or neat or unconstrained CNT yarns and their sensitivity or gauge factor have been extensively studied including the effects played by the angle of twist and porosity, `strain level and strain rate and others like geometry. The piezoresistivity of CNT yarns originates from the intrinsic resistance of the carbon nanotubes, and from the inter-tube resistance including that of nanotubes in physical contact or the tunneling resistance when nanotubes are separated by a small gap. Initial results on the piezoresistive response of CNT yarns integrated in polymeric matrices are also available. The presence of a polymer in sections of the CNT yarn affects its piezoresistivity and sensitivity significantly. It has been shown that the sensitivity of neat CNT yarn is in the order of 1. However, that of CNT yarns has been shown to be at least one order of magnitude higher. This work includes experimental and numerical results on the piezoresistive response of polymer-embedded or coated CNT yarns subjected to various loading conditions. Some of the most relevant parameters that affect the piezoresistive response of free or unconstrained CNT yarns including the strain rate and strain level are also studied for the polymer-embedded CNT yarns.