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Electrically conductive polymer nanofiber composite with an ultralow percolation threshold for chemical vapour sensing

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Abstract

A flexible conductive polymer nanofiber composite (FCPNC) was prepared by carbon nanotube (CNT) decoration onto the blend polyurethane (PU)/ Polyethersulfone (PES) nanofibers under the assistance of ultrasonication. CNTs were uniformly distributed on the nanofiber surface, which was beneficial to the construction of electrically conductive network. The obtained composite mat possessed an ultralow percolation threshold of 0.056 vol%, and the electrical conductivity was as high as 2.8 S m^{-1} at a relatively low CNT concentration of 0.85 vol%. Also, the introduction of CNTs increased both the tensile strength and Young's modulus of the nanofiber mat. The FCPNC with good electrical conductivity and interconnected porous structures was then used as a chemical vapour sensor, which was based on the change of the distance among the conductive nanofibers and hence the electrical conductivity, resulting from the adsorption and desorption of organic vapours. The sensing selectivity of the FCPNC was determined by the solubility parameters as well as the saturated vapour pressure. When the FCPNC with a CNT content of 0.5 vol% was exposed to the acetone vapour, the response intensity (R_I) could reach ~8.8×10^2, while the response rate (R_R) was only 9 s. The resistance was able to return to its original value when the sample was taken out from the vapour to air, and the R_I could retain 90% after tenth cycle test, displaying a good reproducibility.

Keywords: Polymer-matrix composites (PMCs); Electrical properties; Scanning electron microscopy (SEM); Electro-spinning.