THE EFFECT OF BULK DENSITY ON THE PERFORMANCE OF SINGLE-WALLED CARBON NANOTUBE-THERMOSET NANOCOMPOSITES

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Due to the unique ensemble of structural properties [1], high chemical and thermal stability [2], yet tailorable surface composition and inherent high electrical and thermal conductivities [1-4], carbon nanotubes (CNTs) are the frontline material for the manufacturing of advanced electrically conductive polymer matrix composites (PMCs) [5-7]. Bulk density is one of the rare CNT parameters almost unexplored so far for its effect on PMCs, while the fine-tuning brings interesting features [5, 6].

Here we assess the role of the bulk density of single-walled carbon nanotube (SWCNT) powder on the final electrical and thermal properties of SWCNT/thermoset. Three density states of the same nanotubes were used to determine the effect of pre-manufacturing density on the final nanocomposite properties, while masterbatches were used as a comparative reference for performance. Two procedures were employed to alter the pristine bulk density of the pristine SWCNT powder (18 g/l); supercritical fluid-based dispersion (1.6 g/l) and pneumatic compression (450 g/l). The findings showed that the bulk density showed no significant effect on the electrical (~ 10-7 - 1 S/cm) and thermal (0.210 - 0.304 W/mK) conductivities of the nanocomposites. Unexpectedly, percolation thresholds of altered density powders were close to those of masterbatches (0.001-0.003 wt. %). The study shows that compressed nanotube powder provides electrical and thermal performance close to pristine powder and pre-dispersed masterbatches, while being free from common drawbacks such as the higher price of masterbatches and aerosolization during handling of the powder. This new route offers a cheap, matrix-free, and safe manufacturing solution with equitable final properties for SWCNT/thermoset nanocomposites.We thank the Council on grants of Russian Federation (grant number HIII-1330.2022.1.3) and the Russian Science Foundation (project No. 21-72-20050).

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