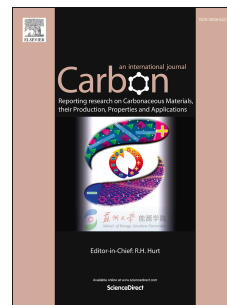


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Performance of nano-carbon loaded polymer composites: Dimensionality matters

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# 1 Performance of Nano-carbon loaded Polymer composites: 2 Dimensionality Matters

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10 Keywords: nanocomposite, carbon, dimension, graphene, nanotube, percolation.

11

## 12 Abstract

13 A comparative study was conducted on composite materials having various nanocarbon fillers  
14 of different dimensionalities, namely, 1D carbon nanotubes (CNTs), 2D graphite nanoplates  
15 (GNPs), and 3D graphite. Comprehensive mechanical, electrical and rheological studies  
16 illustrated the complexity of selecting the optimal nanocarbon filler. We found that the  
17 mechanical performance of the composite to be optimal near the percolation threshold  
18 concentration of the filler for all the nanocarbons. The 1D CNTs strongly affected the  
19 electrical conductivity and reinforcement of the composite, yielding a narrow range of optimal  
20 performance at the lowest filler concentration (0.15 wt%), albeit at the cost of high viscosity.  
21 The 2D GNPs demonstrated a wider range of reinforcement with a milder influence on the  
22 viscosity at a moderate GNP concentration (3.5 wt%). The 3D graphite filler exhibited similar  
23 behavior to that of GNPs, although at a much higher concentration (25 wt%). We introduced a  
24 robustness factor as a measure of the filler concentration range at which a valuable reinforcing  
25 effect is achieved; this factor increases with the filler dimensionality. These contradicting  
26 dimensionality effects are condensed into a figure of merit that takes into account the  
27 rheological effect, the mechanical enhancement, and the filler concentration and robustness.

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