Monte Carlo Simulation of Piezo-Resistive Properties in Nanocarbon-Epoxy Composites

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Nanocarbon-epoxy composites exhibit promising piezo-resistive properties, making them highly suitable for advanced strain-sensing applications. Our study investigates the influence of particle shape on the piezo-resistive behaviour of such composites. **Figure 1** presents experimental results showing distinct trends in resistance changes under tension and compression for different particle geometries. Notably, graphene nanoplatelets (GNPs) demonstrate a unique response under compression, which is absent in carbon black (CB) and multi-walled carbon nanotubes (MWCNTs).
To complement these experiments, we employed Monte Carlo simulations to model the spatial arrangement of particles with varying shapes and constructed a resistor network to calculate the composite's effective conductivity under strain. The simulation results, shown in **Figure 2**, replicate the experimental observations, further highlighting the critical role of particle geometry in modulating piezo-resistive performance.
This integrated approach provides new insights into the relationship between particle shape, percolation behaviour, and conductivity. Our findings offer a framework for tailoring nanocarbon-epoxy composites to achieve optimised piezo-resistive properties, advancing their application in next-generation sensing technologies.

Figures

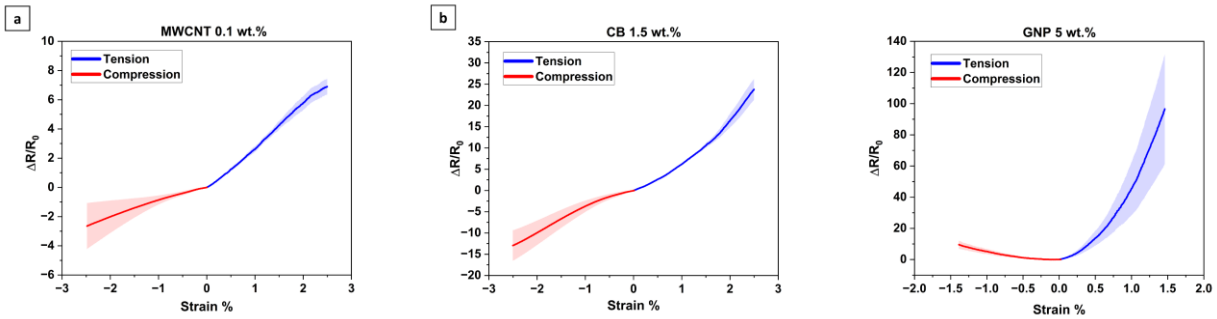

Figure 1: Experimental Piezo-Resistive Behaviour of Nanocarbon-Epoxy Composites under Tension and Compression

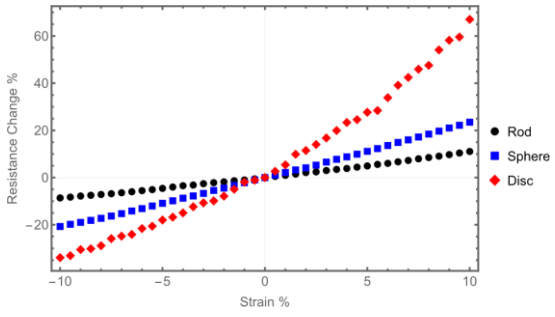

Figure 2: Simulation Results of Resistance Change for Different Particle Shapes under Strain and Compression