

Highly stable nanofluids from oxidized multiwalled carbon nanotubes and graphene with enhanced thermal conductivity

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Heat transfer fluids are important for thermal management in energy and electronics devices. Nanofluids which consist of adding nanomaterials into a solvent have shown superior thermal properties. Carbon nanomaterials (or nanocarbons), including carbon nanotubes and graphene, present high stability and outstanding thermal properties making them excellent candidates to design high-performance nanofluids. Besides the thermal conductivity enhancement, an homogeneous dispersion and proper stability of the nanomaterial in the solvent are mandatory for a nanofluid, although the last two are barely addressed in the literature. Furthermore, carbon nanomaterials are highly hydrophobic and the presence of strong van der Waals forces promotes their self-aggregation. The non-covalent functionalization is a simple approach involving surfactants that will adsorb on the nanocarbon surface forming a coating layer known for increasing the nanomaterial dispersity and dramatically limiting its thermal properties. The covalent functionalization is a powerful approach to modify the nanocarbon surface properties but it also damages them, which consequently hinders their intrinsic thermal properties. In this work, we show how to prepare nanocarbon based nanofluids that are highly stable and with good thermal properties. The finding compromise in the functionalization force applied to multiwalled carbon nanotubes (MWCNTs) and graphene nanoplatelets (GNPs) allows limiting the structural damage and provides good dispersion stability without using any surfactant. The behavior and the chemical reactivity of the modified MWCNTs and GNPs is compared and discussed with regards to the resulting nanofluid thermal conductivity and stability over time, based on their characterization by transmission electron microscopy, Raman spectroscopy and thermogravimetry analysis.