Graphene nanofluids for enhanced heat transfer

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Heat Transfer Fluids (HTFs) have been extensively used from low-temperature applications (like microelectronics cooling) to high-T ones (i.e. concentration solar power). Yet, the low thermal conductivity of liquids leaves much room for improvement.
Heat Transfer Nanofluids (HTNFs) provide enhanced thermal properties by dispersing nanoparticles into base fluids [1].
Graphene is a major contender to produce this type of nanofluids given its excellent thermal properties.
We have developed stable graphene nanofluids with enhanced thermal properties, suitable for their application in the field of thermal energy conversion and storage. Thus, we have i) prepared graphene nanofluids in suitable base fluids (dimethylacetamide /dimethylformamide) ii) determined the influence of graphene concentration on the nanofluid thermal conductivity, iii) established the graphene concentration needed to produce the highest possible thermal conductivity using the same base fluid and iv) found out the concentration limit of graphene able to be dispersed without precipitation.

These nanofluids have homogeneous composition and are stable over time, which are key factors for a proper thermal characterization and for their final application.

A modified 3-ω technique adapted to liquid samples has been developed to measure thermal conductivity [2]. Most thermal conductivity measurements for fluids reported in the literature have been done by using the transient hot wire method. However, this method requires a considerable volume of sample; while the modified 3-ω technique only demands a single droplet to obtain thermal conductivity value. Moreover, small volumes of liquids partially avoid convection transport, improving measurement accuracy.
We will present and discuss both experimental details of our own graphene nanofluid materials, stable as low-T fluids, and description and measurements of our modified 3-ω method suitable for measuring thermal conductivity in liquids. Our results show how a small percent (0.18%) of graphene in the nanofluids leads to a substantial improvement (48%) in thermal conductivity (see Figure 1)

References

[1] O. Mahian, A. Kianifar, S. A. Kalogirou, I. Pop, and S. Wongwises, Int. J. Heat Mass Transf., 57(2), (2013) 582–594.
[2] D. W. Oh, A. Jain, J. K. Eaton, K. E. Goodson, and J. S. Lee, Int. J. Heat Fluid Flow, vol. 29 (2008) 1456–1461.

Figures

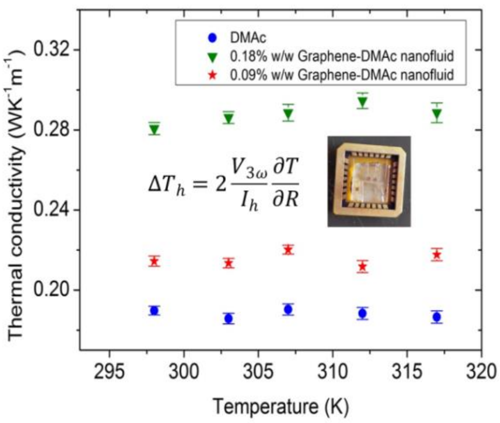

Figure 1: Thermal conductivity data as a function of temperature for dimethylacetamide and graphene nanofluids, 3-ω cell image and equation used.