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## **Influence of the functionalization treatment on thermal conductivity and stability of carbon-based nanofluids.**

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Mainly used for heat transfer applications, nanofluids are defined as a fluid containing nanoparticles. The fluid will serve mainly as solvent, being generally water or oil. Among the existing nanomaterials, carbon nanomaterials present outstanding properties, especially their thermal conductivity which has been the subject of study for researchers mainly in recent years. Using carbon nanomaterials in nanofluids offers the possibility to exploit these amazing properties by bringing them to a macroscopic context<sup>1,2</sup>. To obtain a high performance nanofluid, a proper dispersion of the nanomaterial in the solvent is mandatory. Unfortunately, carbon nanomaterial surface is highly hydrophobic with a high tendency to self-aggregate due to the existence of strong van der Waals forces which hold them to properly disperse in most polar liquids<sup>3</sup>. Therefore, a chemical modification or functionalization of the material surface is compulsory. This last usually involves the use of strong oxidants that will help to increase the hydrophilicity by attaching functional groups on the material surface. However this modification disrupts the nanoparticle structure directly hindering its native properties, being the thermal conductivity not an exception.

In this work high performance carbon-based nanofluids were prepared using functionalized carbon nanotubes and graphene. With the aim to clarify the questions that are important and that still remain open since they are delicate to deal with, we evaluated the strength and impact of different functionalization treatments in the nanofluid final thermal conductivity. A wide study of the obtained nanofluids stability and thermal conductivity was also performed. At first, both nanotubes and graphene were functionalized by 3 different covalent methods. Later, the functionalization was confirmed with the help of electron microscopy, Raman spectroscopy and X-ray photoelectron spectroscopy as well as by mass spectrometry coupled with thermogravimetry analysis. Secondly, the already modified nanoparticles served to prepare nanofluids. Nanofluid thermal conductivity and stability were later evaluated. For each nanofluid, the thermal performances and the stability over time of the prepared nanofluids were discussed by taking into account the functionalization strength applied to each kind of carbon nanomaterials.

<sup>1</sup> A. Banisharif, P. Estellé, A. Rashidi, S. Van Vaerenbergh, M. Aghajani, Colloids and Surfaces A: Physicochemical and Engineering Aspects. 622, 126720 (2021).

<sup>2</sup> S. Halelfadl, T. Mare, P. Estelle, Exp. Therm. Fluid Sci. 53, 104–110 (2014).

<sup>3</sup> M. Pavía, K. Alajami, P. Estellé, A. Desforges, B. Vigolo, Advances in Colloid and Interface Science, 17 (2021).