Graphene Nanofluids- From Thermal to Electrochemical Applications

P. Gómez-Romero

R. Rodriguez-Laguna, E. Chavez-Angel, C. M. Sotomayor-Torres, D.P. Dubal, Z. Caban-Huertas, B. Nagar, C. Marchante, D. Rueda-García, R. Benages

Catalan Institute of Nanoscience and nanotechnology, ICN2 (CSIC-BIST), Campus UAB, 08193 Cerdanyola (Barcelona) Spain

pedro.gomez@icn2.cat

Graphene is the advanced material of choice for a wealth of applications, but it has customarily been used as a solid. Yet, fluids are key materials for a variety of industrial applications, from thermal to electrochemical devices.

Graphene Nanofluids, formed by graphene nanosheets dispersed in suitable base fluids can be prepared as stable dispersions in organic or aqueous solvents [1] and they show most interesting thermal and electrochemical properties.

Thus, for the field of thermal energy conversion and storage, we have developed stable graphene nanofluids of different concentrations in suitable organic solvents as base fluids (dimethylacetamide /dimethylformamide) and have shown their enhanced thermal conductivity (Figure 1) using a modified 3-ω technique adapted to liquid samples[2].

And related to electrochemical energy storage, we have developed electroactive nanofluids based on Reduced Graphene Oxide (RGO) dispersed in acidic aqueous electrolytes showing ultrafast charge transfer (Figure 2) [1]

We will present and discuss both experimental research lines with examples such as the 48% increase in thermal conductivity of our 0.18% graphene in DMAc nanofluid (Figure 1) or the capacitive response of an aqueous RGO nanofluid at the very fast scan rate of 10000 mV/s (Figure 2).

References

[1] D. P. Dubal and P. Gomez-Romero, 2D Mater., vol. 3(3), (2016) p. 31004.

[2] M. R. Rodríguez-Laguna, A. Castro-Alvarez, M. Sledzinska, J. Maire, F. Costanzo, B. Ensing, P. Ordejón, C. M. Sotomayor-Torres, P. Gómez-Romero and E. Chávez-Ángel submitted (2018)

Figures

$$\Delta T_h = 2 \frac{V_{3\omega}}{I_h} \frac{\partial T}{\partial R}$$
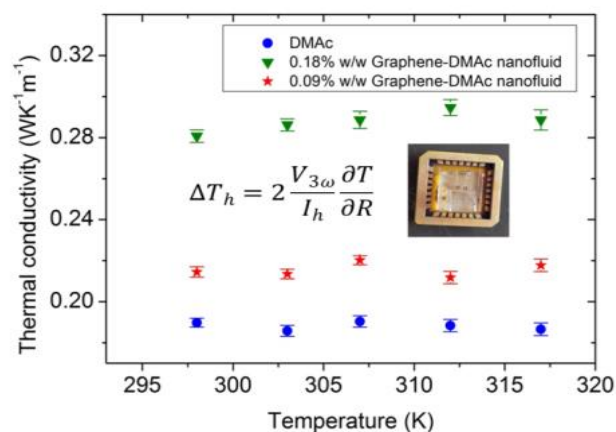
Figure 1: Strong enhancement of thermal conductivity with tiny amounts of graphene in dimethylacetamide nanofluids (up to 50% increase for the 0.18% graphene nanofluid)
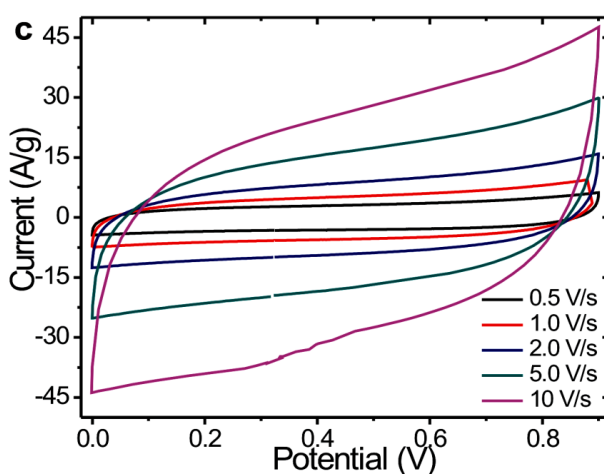
Figure 2: Cyclic voltammograms of graphene nanofluids (in this case RGO in water) showing high capacitive signals even at extremely high scan rates