High-quality graphene-based epoxy nanocomposites via supercritical CO2-assisted exfoliation

Silva, Leonel; Camargo, Javier; Calderón Bedoya, Pedro; Fanovich, Alejandra; Tomba, Pablo

INTEMA-CONICET, Universidad de Mar del Plata, Mar del Plata

leonelsilva@fi.mdp.edu.ar

Área temática: A. Síntesis de nanomateriales

Supercritical CO2 (scCO2) was used as an organic solvent-free medium for graphite exfoliation, including direct processing in 1,4-butanediol diglycidyl ether (BDE) epoxy monomer. Five graphite precursors with distinct morphologies were evaluated, revealing a strong dependence of exfoliation efficiency on lateral size (L). The yield decreases systematically with increasing L, indicating that projected basal area governs interlayer separation under fixed scCO2 conditions. Exfoliation occurs during rapid depressurization after CO2 intercalation between graphene layers. Raman analysis confirmed the formation of few-layer graphene, as evidenced by the shift and reshaping of the 2D band while maintaining an I_D/I_G ratio comparable to the graphite (aprox. 0.2), indicating the absence of additional Raman-detectable defects. The exfoliated graphene exhibited electrical conductivity on the order of 10^4 S m^{-1}. Direct exfoliation in the presence of the epoxy monomer 1,4-butanediol diglycidyl ether (BDE) under scCO2 enabled depressurization-assisted in situ preparation of nanocomposites without intermediate organic solvent exchange or drying steps. The resulting composites displayed a percolation threshold of 6.7 wt.% and reached conductivities in the 10^{-3} S m^{-1} range at 12 wt.% graphene. These results show that morphology-controlled scCO2 exfoliation can be directly coupled with epoxy processing to obtain electrically conductive nanocomposites through an organic solvent-free route.

Referencias

1. K.S. Novoselov, A.K. Geim, Science 306 (2004) 666–669.

2. Z. Sun, Q. Fan, M. Zhang, S. Liu, H. Tao, J. Texter, Advanced Science 6 (2019) 1901084.

3. T.G. Maraschin, R.V. Gonçalves, M.C. De Vargas, R. Correa, N.R.S. Basso, G.B. Galland, E. Cassel, FlatChem 45 (2024) 100656.