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Dispersion and individualization of SWNT in hydrosoluble polymer solutions

10 - Matériaux fonctionnels

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F. Torres-Canas ¹, C. Zamora-Ledezma ², C. Blanc ¹, P. Silva ², E. Anglaret ¹.

¹L2C-UM2 - Montpellier (France), ²IVIC - Caracas (Venezuela, république bolivarienne du).

Carbon nanotubes are widely used as nanocharges in polymer matrix composites for improving mechanical or electrical properties. Nanocomposites can be prepared either in the solid or in the liquid state, and in the latter case by mixing nanotubes with either melted polymers or polymer solutions. To date, controlled dispersion of CNTs in a solution or a composite remains a challenge, due to the strong van der Waals binding energies associated with the CNT aggregates. Dispersion of nanotubes with high yields, as well as high amounts of individual nanotubes, can be prepared in water with the help of surfactants. However, when using such suspensions as precursors for nanocomposites, the final materials will contain some surfactants which will influence their physical properties. On the other hand, dispersing nanotubes directly in polymer solutions without using surfactants leads to low yields and poor individualization.

In this work, we propose an alternative and simple way to disperse single-walled carbon nanotubes (SWNT) in aqueous solutions of two hydrosoluble polymers, polyvinyl alcohol (PVA) and polyvinyl pyrrolidone (PVP). We measure the yield using visible-NIR absorption spectroscopy, and we probe both the chemical environment of the nanotubes and the effectiveness of individualization from coupled Raman/Photoluminescence studies. First, we mix aqueous suspensions of SWNT stabilized with bile salts (BS) with aqueous solutions of PVA, and we evidence a direct exchange of BS molecules and PVA chains at the surface of SWNT. By contrast, no exchange is observed with PVP. Second, we show that a simple dialysis process leads to the preparation of aqueous suspensions of SWNT covered by PVA or PVP with high yields and an effective individualization of the nanotubes. This simple method opens a new way for preparing surfactant-free polymer matrix composites with high concentrations of individual SWNT.