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Dispersion of Carbon Nanotubes Using Nonylphenol Commercial Surfactant

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Since the discovery of carbon nanotubes (CNTs) [1] they have attracted significant attention from researchers due to their mechanical properties, including elastic modulus and stress fracture of approximately 1TPa and 36 GPa, respectively [2]. Also, different synthesis methods produce packed nanotubes; this appearance is due to the Van der Waals intermolecular forces that hold them together. The agglomerations represent a decrease in the final mechanical properties [3, 4]. Much research has been carried out to obtain carbon nanotubes homogeneously dispersed, employing reactive grade sodium dodecyl sulfate (SDS). By this surfactant have obtained stable suspensions of nanotubes that continue maintained for several months [5, 6]. In this work, purified CNTs was dispersed using commercial surfactant nonylphenol (NP), the solutions were prepared with 1mg of CNTs and to varying concentrations of surfactant dissolved in ethanol. The solutions were placed in an ELMA ultrasonic bath at a frequency of 40 Hz for 60 min, to promote deagglomeration. After this time the colloidal solutions were left at rest for 24 h. SEM, TEM and UV-vis spectroscopy characterized the CNTs dispersion.

Figure 1 shows the UV-vis spectrograms of the CNTs dispersed with NP surfactant. The red line situated at 270 nm corresponds to 0.5 g/mL which indicates that there is a uniform size distribution. As observed, at lower surfactant concentrations, the CNTs favored the electrostatic repulsions that help repel one another. When the concentration of surfactant increases, the critical concentration has exceeded, and some molecules of surfactant invert their orientation; causing CNTs agglomeration, which leads to its precipitation and the solutions look more transparent.

The CNTs dispersed were observed by SEM. Figure 2a indicates that the best concentration to get a good dispersion is 0.5 g/mL. In the following figures 2b-2f, the agglomeration is evident, produced by the increase in the concentration of surfactant. It is noticed that are distributed throughout the sample holder without the formation of agglomerates. Where it which are consistent with the UV-vis results.

Once the best dispersion was obtained it was analyzed by TEM to know the structural details of the carbon nanotubes. Figure 3a shows a bright field image, where the carbon nanotubes are individual and intertwined due to the solvent used in preparation for this technique (ethanol). Figure 3b, it is seen that some nanotubes are approximately 1 μm of length, and Figure 3c displays a high resolution image, where the diameter is about 70 nm of course depending on the width of the nanoparticle that they grow.

In this work, it was demonstrated that it is possible to disperse CNTs using nonylphenol surfactant, which is cheaper compared to SDS. A homogeneous and stable dispersion is possible using low concentrations of surfactant and short ultrasound times [7].

References:

[1] S Iijima, Nature **354** (1991), p. 56.

[2] B Guo et al., Carbon **139** (2018), p. 459.
[3] C Guignier and M-A Bueno, Journal of Industrial Textiles, (2018), p. 1528083718769941.
[4] A Feng et al., Nano **13** (2018), p. 1850037.
[5] X Song et al., Chemical Engineering Science **187** (2018), p. 406.
[6] H Gu et al., Carbon **142** (2019), p. 131.
[7] The author I. Santos-Ramos gratefully acknowledges financial support to CONACYT and UJAT. to the UMSNH for the use of the facilities.

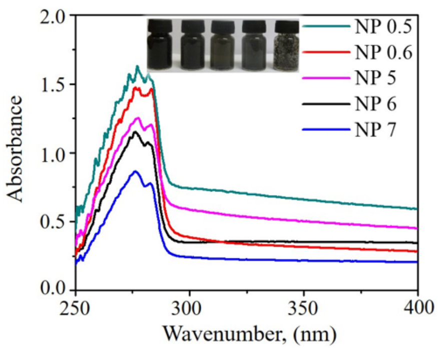

Figure 1. Dispersion of carbon nanotubes analyzed by UV-vis spectroscopy.

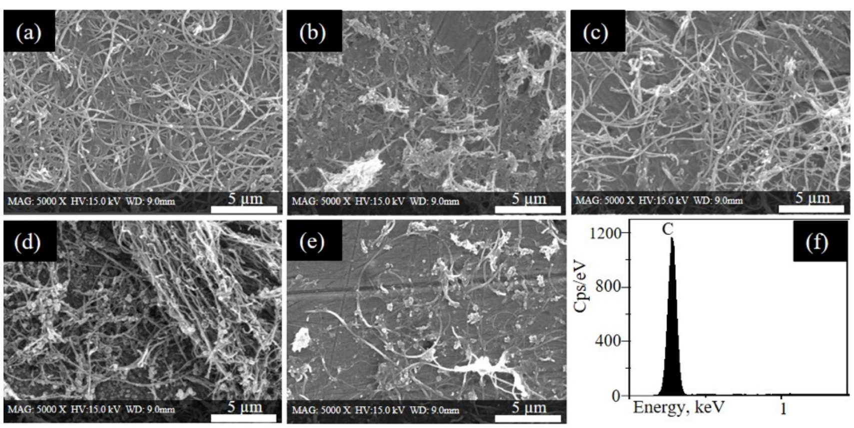

Figure 2. Analysis of the dispersion using different concentrations of nonylphenol by SEM, a) 0.5 mg/mL, b) 0.6 mg/mL, c) 5 mg/mL, d) 6 mg/mL y e) 7 mg/mL, and f) EDS analysis.

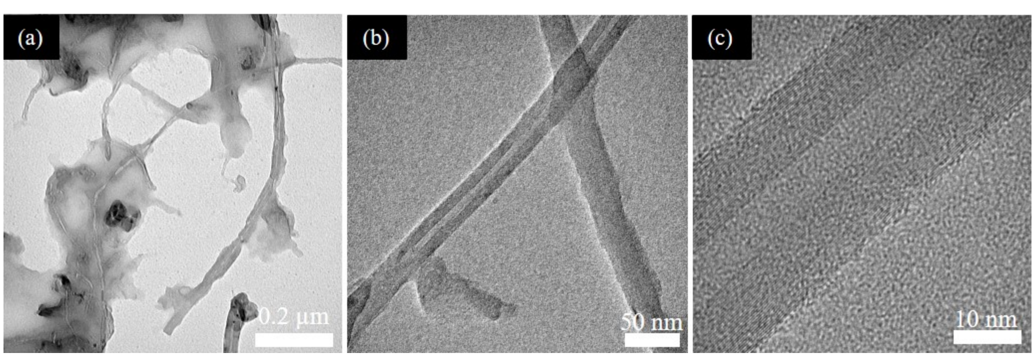

Figure 3. Structural characterization of CNTs by TEM. a) Bright field, b)-d) HR-TEM.

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