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The effect of different chemical treatment and presence of surfactant on the stability of multi-walled carbon nanotubes aqueous dispersion

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Abstract – Multi-walled carbon nanotubes (MWNTs) have be dispersed in water after pretreatments with H_2SO_4/HNO_3 acid mixture and H_2O_2. This work reports on the effect of these previous treatments on the stability of the MWNT aqueous dispersion, as well as the effect of the addition of the surfactant sodium dodecyl sulfate (SDS) on the stability of the aqueous dispersion of both treated and untreated MWNT samples. The stability of suspensions was followed by UV-Vis spectroscopy. The effects of time of sonication of the dispersions and the concentration of MWNT have also been studied. Results indicate that the H_2SO_4/HNO_3 treated MWNTs (without the SDS) and the pristine MWNTs/SDS provided the more homogeneous and stable dispersions.

Aiming several important technological applications, as in the preparation of composite materials, carbon nanotubes (CNTs) should be able to be prepared in aqueous dispersion that remains stable over a suitable period of time. Due the non-polar nature of the CNTs surface, the preparation of stable aqueous dispersion of this material requires previous chemical treatment (in order to create polar chemical groups on the CNTs surface)[1] or the utilization of adequate surfactant compounds such as sodium dodecyl sulfate (SDS)[2]. The most popular surface modification technique involves grafting hydrophilic oxygen-containing functional groups into the exterior CNTs graphene sheet, by using strong acids and/or oxidizing agents[1].

Recently, some of us have reported the synthesis and characterization of a iron- and iron oxide-filled multi-walled carbon nanotubes, based on the pyrolysis of ferrocene in a poor oxygen-containing atmosphere[3]. In this work we report the effect of the different chemical treatment (H_2SO_4/HNO_3 mixture and H_2O_2) and the utilization of SDS on the stability of the aqueous dispersion of these iron-rich MWNTs.

The samples were prepared by refluxing pristine MWCNTs in a 3.0 mol L^{-1}/ HNO_3 3.0 mol L^{-1}/H_2SO_4 aqueous solution during 6h, and in a 30% (w/w) H_2O_2 aqueous solution during 2h. The treated-MWNTs were subsequently separated by centrifugation and washed several times with desionized water until neutral pH. Aqueous dispersions with all samples have been prepared in 0.01; 0.02 and 0.03 wt% of CNTs, by adding the dispersion in an ultrasonic bath for 10, 20, 40, 80 and 120 min. The stability of all the dispersions were evaluated by UV-Vis spectroscopy measuring the intensity of the band at 270 nm, characteristic of dispersed (de-bundled) MWNTs. Time-dependent sonication experiments reveal that the maximum achievable dispersion of MWNTs corresponds to the maximum UV-Vis absorbance of the solution. It was founded that the MWNTs dispersions with acid mixture treatment and pristine MWNTs/SDS required more sonication energy to achieve a maximum dispersion (2h). The absorbance of all the MWNTs dispersions decreases with time, indicating loose of dispersion stability. This effect is more evident for all the modificated-MWNTs/SDS systems, which can be associated with different densities of functional groups created on CNTs surfaces after acid and peroxide treatment. Results indicate that the more stable dispersions are the prepared with acid-treated MWNTs (without SDS) and the pristine MWNTs/SDS. The results obtained for this last dispersion is presented in Figure 1, showing excellent stability of dispersion after 7 hours in the rest.

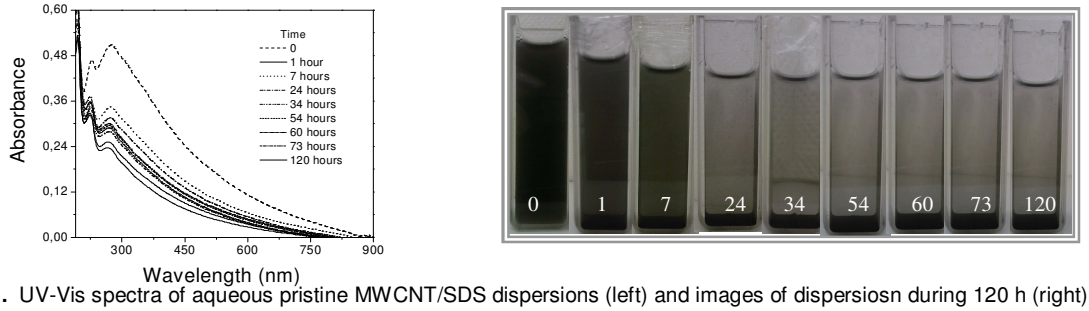

Figure 1. UV-Vis spectra of aqueous pristine MWCNT/SDS dispersions (left) and images of dispersiosn during 120 h (right)

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