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Measurement of the dispersion stability of pristine and surface-modified multiwalled carbon nanotubes in various nonpolar and polar solvents

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Abstract
A qualitative and rapid measurement technique based on multiple light scattering was employed to analyze the dispersion stability of black multiwalled carbon nanotube (CNT) suspensions. Pristine and chemically oxidized CNTs were dispersed in various polar and nonpolar solvents. The change in the transmission of near-infrared light from the suspensions was periodically measured along the height of a sample cell at room temperature. Using this method, it was possible to obtain the variation of the dispersion stability within only a day. Pristine and surface-modified CNTs dispersed in nonpolar media aggregated within 2 h and sedimentation progressively proceeded with time. As the polar component of the solubility parameter and the solubility in water decreased, faster aggregation and severe sedimentation occurred and vice versa. When the CNTs were modified with carboxylic anion groups, the dispersibility in polar solvents was significantly enhanced due to the combination of polar–polar affinity and electrostatic repulsion, with the result that the transmission flux remained unchanged. The origin of electrostatic repulsion can be found from the increased zeta potential and conductivity of CNTs with carboxylic anion groups.

Keywords: carbon nanotube, surface modification, oxidation, dispersion, stability

1. Introduction

Currently multiwalled and singlewalled carbon nanotubes (CNTs) have come into the spotlight in nanoscience and nanotechnology since they were discovered in 1991. Their enforced mechanical [1], electrical [2] and optical properties [3] have attracted the material industry and academic society. Owing to their great possibilities, CNTs are expected to substitute a variety of classical materials in the near future.

However, CNTs with their high van der Waals force, surface area, high aspect ratio inevitably cause self-aggregation. The improvement of dispersion has become a challenge to maximize the properties of CNTs [4]. In order to overcome self-aggregation, chemical modification of the CNTs' surface or utilization of surfactants is regarded as an effective way to improve their wettability and adhesion to host matrix materials [5]. When surfactants are employed in CNT dispersions, surfactant molecules

