ARTICLE IN PRESS

Available online at www.sciencedirect.com

ScienceDirect

Journal of Physics and Chemistry of Solids ▮ (▮▮▮▮) ▮▮▮–▮▮▮

JOURNAL OF PHYSICS AND CHEMISTRY OF SOLIDS

www.elsevier.com/locate/jpcs

Multiple light scattering measurement and stability analysis of aqueous carbon nanotube dispersions

Hun-Sik Kim, Won-Il Park, Minsung Kang, Hyoung-Joon Jin*

Department of Polymer Science and Engineering, Inha University, Incheon 402-751, Republic of Korea

Received 15 June 2007; received in revised form 1 October 2007; accepted 30 October 2007

Abstract

In this study, surfactants were selected for the process of dispersing carbon nanotubes (CNTs) in water, in order to minimize the impact of the chemical modification of the individual CNTs on their inherent properties. The CNTs were sonicated in aqueous solutions of the various surfactants, viz. the anionic sodium dodecylbenzene sulfonate, the cationic cetyl trimethylammonium bromide, and the non-ionic Triton X-100, in order to stabilize the CNTs against the van der Waals attractive forces. The concentration of each surfactant was approximately 0.3 wt% and the concentration of CNTs used for their homogeneous dispersions in aqueous solution was 0.02 wt%. Furthermore, the stabilizing abilities of the aqueous CNT dispersions were measured using a recently developed optical analyzer (Turbiscan). This study shows that the surfactants successfully stabilized the aqueous CNT dispersions, whereas in the absence of surfactants they rapidly sedimented.

Keywords: A. Nanostructures; C. Electron microscopy; C. Scanning tunneling microscopy (STM); D. Optical properties; D. Surface properties

1. Introduction

Carbon nanotubes (CNTs) have attracted an enormous amount of attention since their discovery by Iijima, because of their extraordinary properties, such as their excellent mechanical, electrical and thermal properties [1,2]. Many researchers have tried to incorporate CNTs into various kinds of matrices to produce composite materials with improved electrical conductivity, mechanical properties or thermal stability [2–4]. However, it is difficult to disperse CNTs using ordinary composite fabrication methods, because they are extremely flexible and possess a high aspect ratio [5]. CNTs generally form stabilized bundles through van der Waals forces, resulting in the formation of hollow ropes [6]. The poor dispersibility of CNTs in either water or organic solvents has limited their practical applications and, thus, obtaining a good dispersion of them is one of the key issues in their application to composites [7–9]. To overcome this impediment, research has been focused on the dispersion of CNTs in solvents by either modifying the CNT surface chemistry or by the addition of surfactants [10–12]. However, it is difficult to define the dispersity and stability of CNTs in water with surfactants or organic solvents. Many researchers have utilized atomic force microscopy (AFM), transmission electron microscopy (TEM) and scanning electron microscopy (SEM) for the measurement of the dispersity [13,14], while the measurement of the stability was made with UV spectroscopy or even with the naked eye.

In this study, we prepared well-dispersed multiwalled carbon nanotubes (MWCNTs) containing various surfactants, viz. sodium dodecylbenzene sulfonate (NaDDBS), cetyl trimethylammonium bromide (CTAB), and Triton X-100, in water for the measurement of the dispersity and stability of the aqueous MWCNT dispersion. After measuring the dispersity in each aqueous MWCNT dispersion using SEM, TEM and AFM, we measured the stability using a recently developed optical analyzer (Turbiscan) [15]. The main advantage of this analyzer is its ability to detect destabilization phenomena in non-diluted dispersions, especially in the case of opaque and

*Corresponding author. Tel.: +82 32 860 7483; fax: +82 32 865 5178.
E-mail address: hjjin@inha.ac.kr (H.-J. Jin).

0022-3697/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jpcs.2007.10.062