UNIVERSITI TEKNOLOGI MARA

CROSPOVIDONE-WRAPPED SINGLE WALLED CARBON NANOTUBES SOLUBILITY: SOLUTE-SOLVENT INTERACTION & STRUCTURAL MECHANISM

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CONFIRMATION BY PANEL OF EXAMINERS

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ABSTRACT

Crospovidone is a highly hydrophobic polymer but has a good capability as a carrier and excipient. With the aid of surfactant (SDS), the solubilization of single walled carbon nanotubes (SWNTs) in water has been achieved by polymer wrapping. Polymer wrapped single walled carbon nanotubes (SWNTs) have been synthesized to improve the solubility of SWNTs in water. The synthesized crospovidone wrapped single walled carbon nanotubes (CPVP-SWNTs) have been characterized using the solid state characterization tools such as Fourier transformation infrared spectroscopy (FTIR), Differential scanning calorimeter (DSC), X-ray diffractometer (XRD) and Field emission scanning electron microscope (FESEM) to ascertain the procedure of polymer wrapping. As there has been no literature on the solute-solvent interaction of the wrapped nanoparticles in water, the present study deals with the solute-solvent interaction and thermodynamic parameters during the solubilization of CPVP-SWNTs in water by viscometric, conductometric, volumetric and ultrasonic velocity methods. Viscosity, density and conductometry values of both CPVP and CPVP-SWNTs have been determined in water with different concentrations (0.05-1.2 gm/l) at temperatures 298.15, 303.15, 308.15 and 313.15K. The viscosity values have been evaluated in terms of A_F (Falken-Hagen coefficient), B_J (Jones-Dole coefficient), dB/dt, $\Delta\mu_2°$ (contribution per mole of the solute to free energy of activation for viscous flow of solutions), $\Delta\mu_1°$ (corresponding value for pure solvent) and $\eta_0\Lambda_0$ (Walden product). Meanwhile, the conductance values have been used to evaluate the limiting molar conductance (Λ_0) and the activation energy (E_s). From the density values, the limiting partial molar volumes and expansibilities have been calculated. However, ultrasonic velocity values of both CPVP and CPVP-SWNTs have been determined in water maintaining different concentration (0.05-1.2 gm/l) at only one temperature 298.15 K. Values of sound velocity have been used to evaluate the parameters such as isentropic compressibility (K_s), apparent isentropic molar compressibility (K^0_s), internal pressure (π_i), relative association (R_a), acoustic impedance (Z) and free volume (V_f). It is observed that sound velocity increased with the increase in solute concentration with an almost linear fashion. The compressibility values are observed to decrease with increase in solute concentration and the estimated parameters were discussed in terms of solute-solvent interactions.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Carbon nanotubes have been widely studied since it was discovered by Iijima in 1991. In the following years, a lot of experimental works have been imparted upon them (Calvert, 1999; Gong, Liu, Baskran, Voise and Young, 2000) owing to their unique characters. The single walled carbon nanotubes (SWNTs) acquire unique mechanical, electrical, structural properties (Baughman, Zakhidov, and Heer, 2002; Dresselhaus and Avouris, 2001) and surface area as well as have the potential for surface functionalisation (Wakamatsu, Takamori, Fujigaya and Nakashima, 2009; Al-Saleh and Sundarajaj, 2009; Ma, Yao, Zheng, Yin and Jiang, 2010; Huang, Liu, Wu and Fan, 2005). With all these outstanding characteristics, they have drawn great attention towards the scientific community and researchers. Besides, they exhibited an incredibly strong tensile and a very light weight with good thermal and chemical stability (Banerjee, Jha and Chattopadhyay, 2012; Jha and Ramaprabhu, 2012). As a result, they displayed excellent characteristics for various applications, such as hydrogen storage materials, field emission displays, molecular wires, sensors, high strength fibers (Coleman, Khan and Gunko, 2006; Ouyang, Huang and Lieber, 2002) and biomedical devices (Lin et al., 2004; Koerner, Price, Pearce, Alexander and Vaia, 2004).

There is a growing interest in utilizing single walled carbon nanotubes for a variety of biomedical applications that take advantage of the structural and optical properties of SWNTs. One approach is to use the nanotubes as vehicles for more efficient and targeted drug delivery, potentially allowing for improved cancer therapies due to lower drug dosage and reduced systemic side effects (Liu et al., 2008). Alternatively, researchers have prepared functionalized SWNTs so that they can be readily absorbed by cancer cells and then selectively heated the SWNTs using NIR light (700-1100nm). The SWNTs preferentially absorb the radiation and transfer the heat to their surroundings, causing localized cell death (Kam, O'Connell, Wisdom and Dai, 2005).