Effective Dispersion of BNNTs in Organic Solvents under E-Beam Irradiation with Different Absorbed Doses

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1. Introduction

Boron nitride nanotubes (BNNTs) have superior electrical properties, high thermal stability, neutron shielding, and thermal conductivity compared to structurally similar carbon nanotubes (CNTs) [1]. While BNNTs have promising applications in various fields such as aerospace and medical materials, they remain expensive and difficult to handle [2]. One of the reasons for this is the strong Van der Waals interaction between the tubes, which cause them to exist in bundles and make dispersion challenging. Although there are various dispersion methods available such as surface functionalization and the use of surfactants, many of them alter or damage the surface of the BNNTs, compromising their properties [1, 2, 3]. This study aims to overcome these limitations and increase BNNT dispersibility using electron beam irradiation.

2. Methods and Results

2.1 Sample preparation and irradiation

In this study, Boron nitride nanotubes (BNNTs) were purchased from NAIEL Technologies (NanoBorNT-90) and used as received. Various organic solvents such as DMA, DMF, THF, and NMP were employed as solvents to mix the BNNTs at concentrations of 1 and 10 mg/ml, both as a single solvent and co-solvent. The mixture was subjected to 2 minutes of tip sonication and 30 minutes of bath sonication. Following the ultrasonic treatment, the sample was irradiated with an electron beam from a Korea Atomic Energy Research Institute (KAERI) electron accelerator at four different absorbed doses of 0, 50, 100, and 150 kGy. Finally, the irradiated samples were sonicated in a bath for 30 minutes.

2.2 Observation

The solvent system mixed with the organic solvent was transferred to a glass vial, and photos were taken on days 0, 1, 3, 7, 21, and 28 to measure turbidity and visually observed. We conducted an experiment using both a single solvent and a co-solvent, and found that the electron beam-irradiated solvent had better dispersibility than the non-irradiated solvent. Additionally, we observed higher dispersibility when using a single solvent compared to the co-solvent.

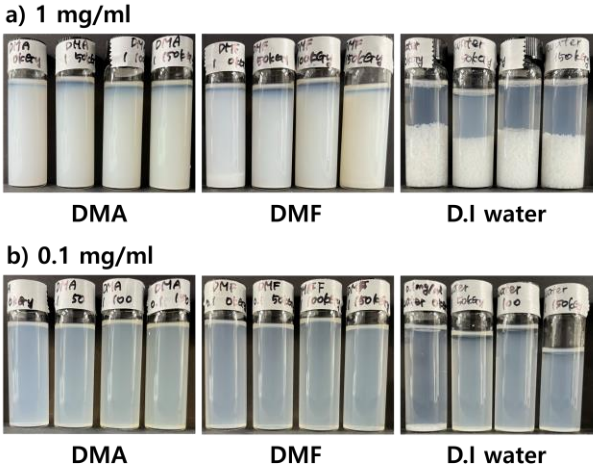

Fig. 1. Photographs of BNNTs dispersed in DMA, DMF, and D.I water at concentration of (a) 1mg/ml and (b) 0.1mg/ml settled for 3 days after irradiation. The absorbed doses are 0, 50, 100, and 150 kGy from left to right.

2.3 FT-IR

The BNNT-solvent was irradiated with different doses of electron beam, and the solvent was removed with DI water. The degree of damage of BNNTs was evaluated by structural analysis such as FT-IR and RAMAN. As a result, it was confirmed that the original peaks of BNNTs appeared, indicating that no damage was caused by electron beam irradiation.

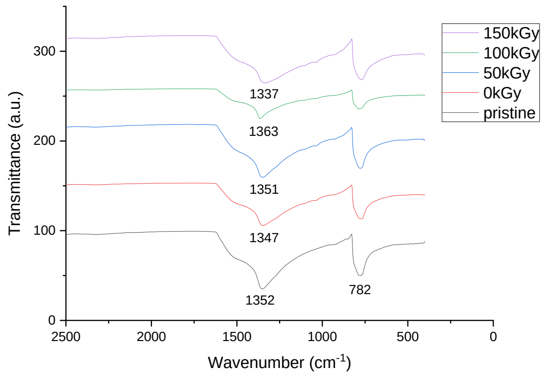

Fig. 2. FT-IR results of BNNTs-solvent irradiated with electron beam. Pristine, 0, 50, 100, and 150 kGy from the bottom.

4. Conclusion and Future work

The study demonstrated that electron beam irradiation enhanced the dispersion of BNNTs in organic solvents, and co-solvents showed better dispersibility than single solvents, as qualitatively evaluated. Furthermore, FT-IR analysis confirmed that the electron beam irradiation did not cause any damage to the BNNTs. Additional studies will be conducted to investigate the dispersing mechanism of BNNTs under the influence of e-beam irradiation.

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