Preliminary study to disperse carbon nanotubes in organic solvents using electron-beam irradiation

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1. Introduction

For the application of 1D nanomaterials with excellent properties to various applications, dispersion technology in various solvents is essential. Conventional dispersion technologies are based on surface functionalization of material or addition of chemical agents in the dispersion [1]. Therefore, intrinsic properties of nanomaterials are inevitably deteriorated due to surface damage or dispersion agents which act as impurities. To maximize the nanomaterial properties and minimize the usage in the application field, a new dispersion concept that assure high dispersibility yet no deterioration of intrinsic properties is required. In this study, we attempted to use electron-beam irradiation to disperse carbon nanotubes (CNTs) in various organic solvents and preliminary results are discussed.

2. Methods and Results

In this section, sample preparation and electron-beam irradiation conditions are described as following.

2.1 Preparation of CNT dispersion solution

In this experiment, multi-wall CNT (MWCNT, Nanointegris > 95wt%, 10-20nm OD) was used. 0.05 g of CNT was added in 5 ml of each solvents (DMSO, NMP, Toluene, DMF, and DMA) [2]. Each samples were ultra-sonicated for 30 min prior to electron-beam irradiation. [3]. Samples were irradiated at a facility of KITECH (EBILU-10-10, 5 MeV) for absorbed dose of 50, 100, and 150 kGy. Absorbed dose were accumulated by increasing the pass number as 2, 4, and 6 at 25 kGy/pass. After irradiation, samples were stabilized for 2 h and subsequently ultra-sonicated for 30 min.

2.2 Visual Observation

To visually observe the dispersion, a portion of the samples were transferred into a 5 ml glass vial. Visual observation was recorded on 0, 1, 3, 5, 7, 14, and 28 days after irradiation. As shown in Fig. 1, preliminary results show that a significant difference in CNT dispersion could be observed within a week after irradiation.

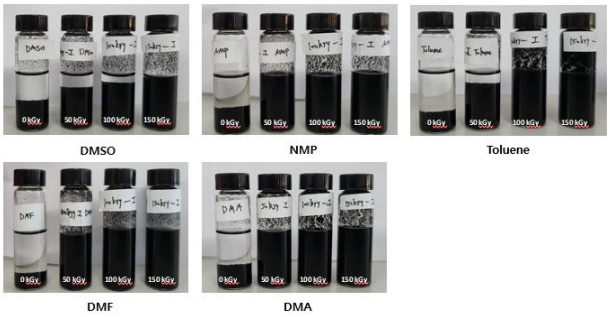

Fig. 1. Visual observation of samples 5 days after irradiation. CNT concentration 10 mg/ml, absorbed dose 0, 50, 100, and 150kGy.

2.3 Raman spectroscopy

The structure of CNT was evaluated by Raman spectroscopy. CNTs were collected from the irradiated dispersions by evaporating each solvents overnight under vacuum. Based on Fig 2, structural defects of CNTs induced by irradiation of dispersions were identified as meaningless levels.

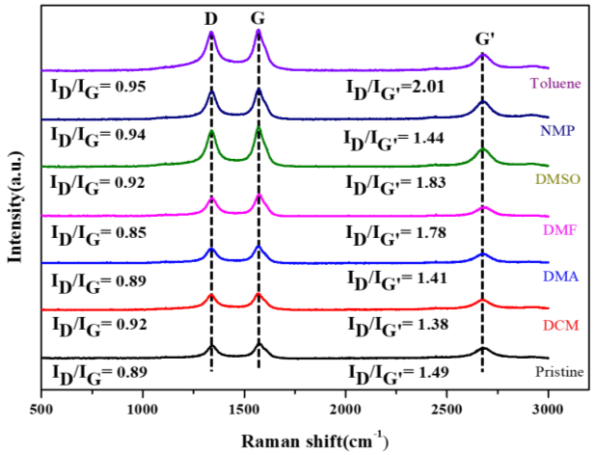

Fig. 2. Raman spectrum of CNTs after irradiation of various organic solvent dispersions.

3. Conclusions

As a preliminary study, we found that the dispersibility of CNT in various solvents were affect by electron-beam irradiation. Dispersion was affected by solvent type, absorbed dose, and elapsed time after irradiation. Raman spectrum confirmed that there were no structural defects in the samples before and after electron-beam irradiation. We believe that these results

lead to a new concept for 1D nanomaterial dispersion technology that can overcome the limitations of conventional methods. For further work, we are planning to evaluate the change of pH, Zeta-potential, etc. and investigate the dispersion mechanism.

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