STRUCTURAL EVALUATION OF OZONE TREATED CARBON NANOFIBERS

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Introduction

Fibrous carbons including carbon fibers, carbon nanofibers and nanotubes have been studied intensively as functional reinforcing filler in various polymers. Actually, full utilization of intrinsic properties of these fibrous carbons incorporated in polymer can be achieved through the optimized interface control between nanotubes and polymers. Therefore, surface treatment through oxidation treatment and the coupling agent can be applied in order to improve adhesion properties between the filler and polymers, resulting in good stress transfer from the polymer to the nanotube. There are various oxidative processes, such as gas, wet, electrochemical and plasma techniques. From the industrial point of view, the ozone treatment is very attractive technique [1-3]. In this study, carbon nanofibers obtained by the floating reactant method was modified by ozone- treatment, and then their structural changes were evaluated, especially, focusing on the surface of carbon nanofibers, by high resolution TEM, Raman, FT-IR, specific surface area and zeta potential.

Experimental

The nanofibers used in this study are synthesized by a floating reactant method using ferrocene as a catalyst precursor, and benzene as a carbon feedstock in a semi-continuous process [1]. Graphitization of the fibers was performed at 2800^{o}C for 30 minutes, using a graphite-resistance furnace operating in a high-purity argon atmosphere. Ozone treatment on graphitized nanofibers was carried out using ozone generator (Meidensha Corp.) by varying temperatures and flows. Field emission

scanning electron microscopy (FE-SEM) (Hitachi S-4100, 5kV), high-resolution transmission electron microscopy (HRTEM) (JEOL JEM 2010FEF, 200kV), Zeta-potential and Raman spectroscopy (Renishaw Raman Image Microscope System 1000 equipped with a CCD multi-channel detector) were used to investigate and characterize the pristine and ozone-treated nanofibers.

Result and Discussion

Figure 1 exhibit the effect of ozone-treatment on highly crystalline carbon nanofibers. The increase in intensity of D band suggests structural disorder on the near-surface of carbon nanofibers, with the introduction of oxygen-containing functional group (carbonyl and ether groups by FT-IR techniques), resulting in increased surface roughness and also specific surface area (from 9.8 to 38 m^2/g). No morphological change is confirmed by FE-SEM. As a result, the optimization of surface morphology (optimized roughness with optimum portion of functional groups) has to be solved without reduced physical properties in order to obtain expected benefit of fibrous carbon-based polymers (in progress).

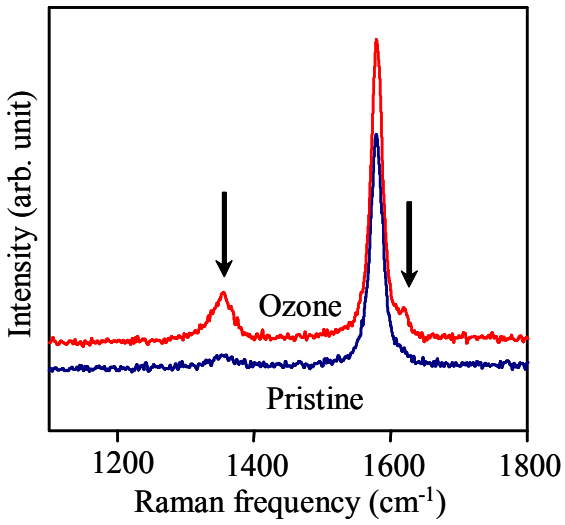

Figure 1. Raman spectroscopy of the pristine and ozone-treated carbon nanofibers.

References

1. T. Takada et al., Carbon 34, 1087 (1996).
2. L. B. Cascarini et al., Carbon 36, 277 (1998).
3. D. B. Mawhinney et al., Chem. Phys. Lett., 324, 213 (2000).

Acknowledgements

This work was supported by the CLUSTER of Ministry of Education, Culture, Sports, Science and Technology.