RECENT RESEARCH ACTIVITIES

Microstructural analysis of carbon composite from phenolic resin and cellulose nanofiber

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Carbon materials with high specific surface area have been used in various fields such as CO_2 gas adsorbent, and electrodes for electric double layer capacitors. The micropores and mesopores of the carbon have great influence on the property of the materials. Micropores less than 2 nm are suitable for CO_2 adsorbent. On the other hand, micropores contribute to the improvement of capacitance, and mesopores contribute to rapid charge / discharge performance in EDLC. Controlling microstructure of carbon material is important because of the dependence of pore size distribution on the required property.

We have conducted microstructural analysis on carbon materials from thermosetting phenol resin. We have prepared carbon composites of phenol resin and cellulose nanofiber (CNF), which is one of the wood components in order to develop porous carbon materials from phenol resin. CNF is renewable resource and porous structure is uniformly formed. In this study, carbonization and activation treatment were carried out by adding potassium hydroxide to composite of phenolic resin and CNF at the same time. The microstructure of obtained carbon composite from phenolic resin and CNF was observed with transmission electron microscopy (TEM).

Phenol, CNF, formaldehyde, and hexamethylene-tetramine were mixed in a reaction vessel. The temperature was kept at 85°C during stirring for 1 hour. Potassium hydroxide, KOH aqueous solution with 50 % was added to the sample and stirred for 30 minutes, and then moisture was removed in a vacuum condition. The obtained residue was dried at 120°C for 24 hours to obtain carbon precursor of phenolic resin and CNF composite containing KOH. The obtained carbon precursor was heat-treated at 800°C for 1 hour. The microstructure of carbon composite of phenolic resin and CNF was observed with TEM.

TEM image of carbon composite of phenolic resin and CNF is shown in Fig. 1. Fig. 1(a) shows the region of the carbonized phenolic resin and Fig. 1(b) shows that of carbonized CNF. Carbonized phenolic resin seems to have relatively large pores compared to those observed for carbonized CNF, in which fibrous texture was observed with oriented state. Smaller pores compared to those of phenol resin were observed. From this result, it is confirmed that the pore diameter developed in the carbon composite differ between the region of phenolic resin and CNF even if the same activator was used.

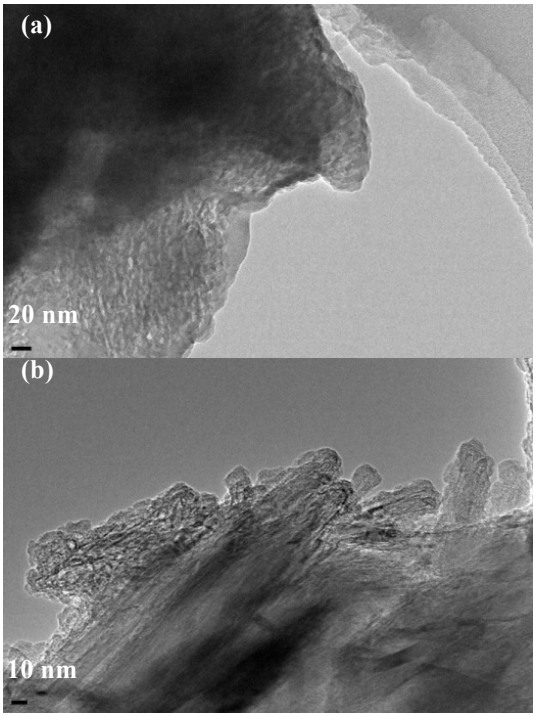

Figure 1. TEM image of carbon composite of phenolic resin and CNF. A: region of carbonized phenolic resin, B: region of carbonized CNF.

From the TEM observation, however, drastic change is necessary on pore structure corresponding to micropores and mesopores in order to get carbon composite of phenolic resin and CNF with high specific surface area.