Preparation and Characterization of Carbon Nanotube Dispersion Exhibiting Liquid Crystal Phase

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Carbon nanotubes (CNTs) are tubular carbon allotrope showing high electrical conductivity (900,000 S/cm[1]) and tensile strength (43-80 GPa[2]). Because of their superior physical properties, CNTs have been expected as lightweight flexible fibers. One of the most promising methods for producing CNT fibers is wet spinning. In this process, CNT solution is injected into a coagulation liquid bath to form the fibers. To improve the fiber properties, CNTs need to be aligned in the fiber. Therefore, liquid crystalline CNT dispersions have been used for the wet spinning. However, systematic study on the liquid crystal (LC) phase behavior of CNT dispersions has so far been limited.

We here used single-walled CNTs purchased from Meijo Nanocarbon (e-Dips) and OCSiAl (Tuball). To disperse CNTs in water, we added sodium-cholate (SC) as dispersants. After sonication, the CNT solution was centrifuged to remove large CNT aggregates and concentrated by ultrafiltration. At the CNT concentration of 0.18 vol %, the dispersion shows isotropic phase (Fig. 1(a)). At the higher concentration (0.49 vol %), nematic LC phase was observed (Fig. 1(b)). The CNT dispersion show biphasic state at the intermediate concentration (0.38 vol %) (Fig. 1(c)). The characteristic spindle LC phases called “tactoid” can be seen in the biphasic phase. By changing the sonication time, we prepared the CNT dispersions which contain different aspect ratio of CNT bundles (L/D). As increasing the aspect ratio, the LC transition occurs at the lower concentration. This trend is consistent with the Onsager theory, but the observed cloud points were lower than the predicted values. This can be explained by van der Waals interaction between CNT bundles[3]. In this meeting, we will also discuss the relationship between the observed tactoid shapes and L/D.

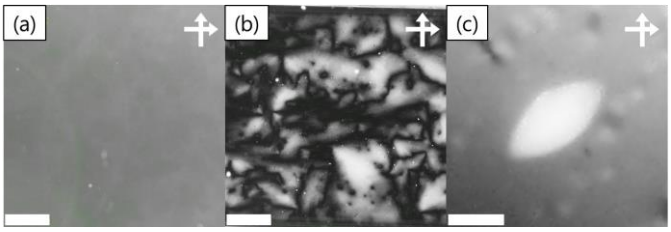

Figure 1. Polarized optical microscope image of CNT micelle solutions with different CNT concentrations ((a) 0.18 vol %, (b) 0.49 vol % and (c) 0.38 vol %). Scale bar: (a, b) 400 μm and (c) 10 μm.

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