Electrorheological Effect of Pd Nanoparticles Dispersed Nematic Liquid Crystals

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The electrorheological (ER) effect denotes a reversible change in the apparent viscosity of certain fluids, such as a colloidal suspension, under an external electric field. The ER properties of composite materials consisting of a nematic liquid crystal (LC) and nanoparticles (NPs) have been studied in our laboratory. For example, the composite material consisting of a nematic LC (4'-pentyl-4-biphenylcarbonitrile, 5CB) and gold nanoparticles (GNPs) with alkyl chains and mesogenic groups showed a higher enhancement in shear stress under an application of electric fields.[1)] However, the detailed mechanism for viscosity increasing in such composite materials is not known. In order to understand the detailed mechanism of ER effect in composite materials, the correlation between the particle size and the viscosity increasing in such composite materials has been studied. Specifically, we synthesized nanoparticles of different sizes, dispersing in liquid crystals and decided to clarify the correlations by measuring their viscosity. Palladium nanoparticles (PdNPs) with various sizes were synthesized in this study, because Pd NPs has better dispersibility than GNPs. The PdNPs were synthesized using an aqueous approach and the sizes were controlled in the range of 6–18 nm by adjusting the rate of reduction of Pd^{2+} ions.[2)] The transmission electron microscope (TEM) image of synthesized 18 nm PdNPs were shown in Figure 1. The dispersity of the PdNPs in the nematic LC was investigated by a polarizing optical microscopy (POM). In the previous study, the presence of the GNPs in the nematic LC led to a slightly enhanced ER effect compared to that observed for only the nematic LC. However, the presence of the PdNPs in the nematic LC led to a reduced ER effect compared to that observed for only the nematic LC as shown in Figure 2.

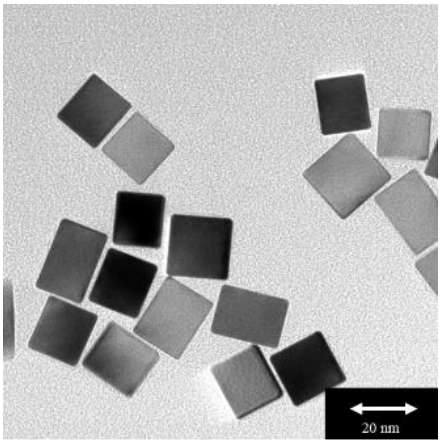

Figure 1. The TEM image of Pd nanoparticles

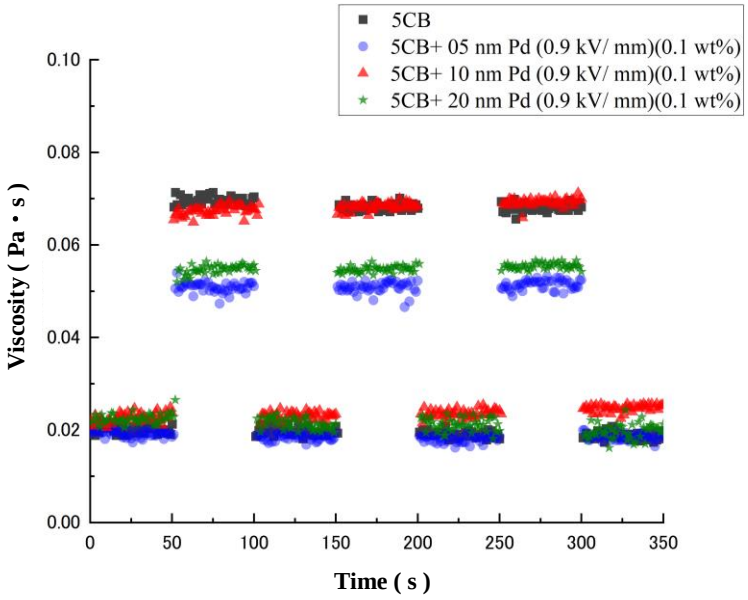

Figure 2. The results of viscosity measurements

1) K. Kaneko,Y. Ujihara, K. Oto, T. Hashishin, T. Hanasaki, *ChemPhysChem*. **2015**, *16*, 919
2) M. Jin, H. Liu, H. Zhang, Z. Xie, J. Liu and Y. Xia, *Nano Res*.**2011**, *4*, 83