UV-Induced Stable Planar Alignment of Nematic Liquid Crystals by Using a Polypropyleneimine Dendrimer Having a Mesogen Consisting of Cinnamate and Azobenzene Moieties

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We have reported that polypropyleneimine dendrimers (PPID) having peripheral mesogenic units tend to align homeotropically on native glass surfaces.1) Mixing a few % of the dendrimer into nematic liquid crystals (NLCs) induced the vertical alignment to whole NLCs.2) Using this, we could prepare a liquid crystalline display without any polyimide alignment layers.2) In this study, we prepared a liquid crystalline dendrimer having cinnamate mesogen containing azobenzene moiety (1) shown in Fig. 1 in order to achieve stable planar alignment upon UV irradiation. It is well known that the azobenzene unit, which is stable in trans-form, converts into cis-form on UV irradiation. Our previous attempt3) using azobenzene mesogens on the dendrimer could induced the planar alignment of matrix NLCs under UV light, but the alignment was not stable and immediately went back to vertical alignment under visible light. In order to fix the planar alignment, we tried to introduce the cinnamate group, which is expected to dimerize to prevent the transformation of cis-azobenzene to trans-form.

The mesogen was synthesized by azo coupling of phenol with a diazonium salt of ethyl 4-aminocinnamate, which was prepared by hydrogenation of commercial ethyl 4-nitrocinnamate and following treatment with sodium nitrite. The mesogen was converted to acrylate by the reaction with 6-bromohexanol followed by the reaction with acrylic chloride. The acrylate was reacted with the commercial 2nd generation PPID at 50 °C for 20 days to give 1. The dendrimer 1 was thermotropic liquid crystal showing following phase transition behavior: SmE 44°C SmB 98°C SmA1 133°C SmA2 160°C Iso. As shown in Fig. 2a, a mixture of ZLI-4792 (Merck) NLC with 1wt% of 1 showed dark field by polarized optical microscope (POM) with crossed polarizer at room temperature. The conoscopic observation showed a typical isogyre (inset in Fig. 2a) and thus indicated the homeotropic alignment of the NLC. After UV irradiation on the same sample, the schlieren texture due to nematic phase was observed (Fig. 2b), and the texture was kept even after 2 weeks (Fig. 2c). Thus 1 can induce the stable planar alignment of NLC upon UV irradiation. Further results concerning polarized UV light irradiation will also be reported.

References:

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Figure 1. Structure of 1.

Figure 2. POM images of mixture of ZLI-4792 and 1 (99/1, w/w) (a) before, (b) just after and (c) 2 weeks after the UV irradiation.