

Synthesis of Remote-Controllable Molecular Knob in the Mesomorphic Helical Superstructures

Geuk-Cheon Bang, Won-Jin Yoon, Dong-Gue Kang, Yu-Jin Choi, Kwang-Un Jeong

Department of Polymer-Nano Science and Technology, Chonbuk National University

Jeonju 54896, Republic of Korea

rmrcjs93@jbnu.ac.kr; wjyoon@jbnu.ac.kr; dgkang@jbnu.ac.kr

choiyujin@jbnu.ac.kr; kujeong@jbnu.ac.kr

Extended Abstract

Since the physical properties of organic materials are closely interconnected to intramolecular conformations as well as to intermolecular self-organizations, the constructions of chemical structure–molecular packing physical property relationships are critical for the development of smart organic materials.¹ Especially, liquid crystal (LC) soft materials have attracted a lot of material scientists because the anisotropic and self-assembly behaviors can maximize the electrical and optical properties.² The azobenzene compound has received a lot of attentions not only because the cooperative conformational changes during the photoisomerization process are fully reversible, but also because the cylindrical molecular shape enhances the compatibility in the host LC media.³ To fabricate remote-controllable molecular knob, a light-responsive chiral liquid crystal (LC) containing four photochromic azobenzene moieties covalently connected to a central bicyclic chiral core (abbreviated as A₄IC) was newly designed. First of all, phase evolutions and ordered structures of A₄IC were systematically investigated by a combination of thermal, microscopic, scattering, and simulation techniques. Wide-angle X-ray diffractions of oriented A₄IC samples indicated that the A₄IC molecule itself basically forms layer structures. At high temperatures, it was recognized that A₄IC molecule formed a low-ordered chiral smectic A (SmA*) LC phase with the 5.61nm layer periodicity. Two highly ordered smectic crystalline (SCR₁ and SCR₂) phases were subsequently formed at lower temperatures with the anticlinically tilted molecular packing structures. Since A₄IC exhibited the chiral nature as well as the good compatibility with nematic (N) LC media, A₄IC can be a promising chiral dopant and a remote-controllable molecular knob. By doping the A₄IC chiral agent into the N media, the mesomorphic helical superstructures such as chiral nematic (N*) and BP were spontaneously constructed. Because of the bent conformational geometry of A₄IC, the thermal window of BP LC was expanded by stabilizing the double twisted cylindrical building blocks. By tuning the light wavelength, remote-controllable phase transformations in the mesomorphic helical superstructures were demonstrated. This work was mainly supported by BRL (2015042417), MOTIE-KDRC (10051334), and BK21 Plus program, Korea.

References

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