MS106.O07

Imaging of nanoscale molecular order in the cybotactic nematic phase

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Bent-core liquid crystals (BCLCs) research has gained significant interest because of their potential to form biaxial and ferroelectric nematic phases. Majority of BCLCs possessing five or six or seven ring systems exhibited smectic like (Banana) and chiral phases. Therefore, it is pertinent and challenging to design BCLCs which could exhibit long-range nematic mesomorphism for promising practical applications. Nematic phase exhibited by BCLCs is distinctly different from the same exhibited by conventional rod like molecules and often called as 'cybotactic' nematic phase (NcybC) which is composed of small smectic C(SmC) type clusters. Traditionally, researchers adopted X-ray scattering technique to recognize the molecular order in the LC phase particularly at small angles (SAXS). However, SAXS, cannot fully give the details of nanoscale (SmC like clusters having short-range) molecular order directly in the nematic (purely orientationally ordered) phase. Therefore, direct imaging of such nanoscale ordered structures in the NcybC is highly desirable and understanding of their properties is very essential for potential applications. In order to face such challenges discussed above, we designed and synthesized achiral four-ring unsymmetrical BCLCs having highly polar terminal group. These BCLCs derived from 2-methyl 3-amino benzoic acid with the methyl group in the bent direction incorporated into the central core. These compounds possess an alkoxy chain attached at only one end of the bent-core molecule, while the other arm consists of a biphenyl moiety possessing a highly polar cyano-group. The molecular structure has been confirmed by elemental analysis and spectroscopic data. Thermal behaviour and phase characterisation have been investigated by differential scanning calorimetry (DSC) and polarising optical microscopy (POM). All the compounds exhibit a wide-range enantiotropic nematic phase. Using Cryo-TEM imaging technique, we have recognized nanoscale molecular order in the cybotactic nematic phase by quenching phase structure to cryogenic temperatures.

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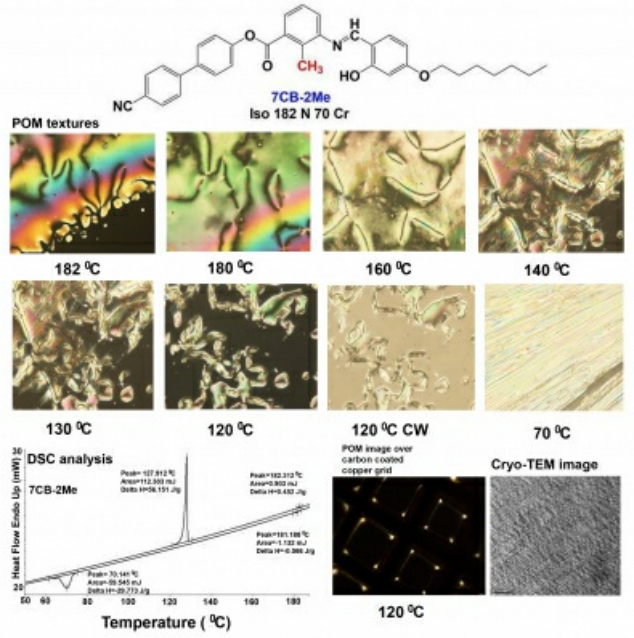

Keywords: Liquid crystals, Nematic phase, Phase quenching