Synthesis, Mesomorphic Behaviour and Optical Anisotropy of Some Novel Liquid Crystals with a 2,6-Disubstituted Naphthalene Core and Lateral Fluoro Substituents

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The variety of liquid crystals that find commercial applications is currently very wide. Nematic liquid crystals dominate commercial applications in displays, and several different device formats are available, for example twist nematic (TN), super-twisted nematic (STN), in-plane switching (IPS) and vertically-aligned nematic (VAN), that require materials of differing specific properties. Ferroelectric liquid crystal displays (FLCD) require smectic C materials with properties tailored for the specific application. Chiral nematic liquid crystals selectively reflect visible light of a wavelength that depends on temperature, and hence find extensive use in a wide range of commercial applications most notably thin-film thermometers, document security logos and specialist paints and coatings. In all such applications the need for high optical anisotropy (birefringence) is increasingly important, for example in displays to allow the advantageous use of thinner cells, and in thermochromic applications to generate an acceptably high brightness. In addition, high optical anisotropy is an essential feature of nematic liquid crystals intended for telecommunications devices, particularly those operating at 1550 nm.

Unfortunately, many structural units conducive towards a high optical anisotropy cause a high melting point, high viscosity, low solubility, low resistivity and low chemical and photochemical stability, features which are incompatible with the materials used in commercial applications. The synthesis, mesomorphic properties and optical anisotropy of a range of fluorinated diphenylnaphthalenes with a terminal pentyl or butoxy chain (1a-c) are detailed. The design of the materials serves to combine high optical anisotropy, through the use of a naphthalene ring and two benzene rings, with a low viscosity, high resistivity and compatibility with existing commercial materials by maintaining a fluoro-hydrocarbon structure. The synthesis of the materials was effected efficiently using a combination of low temperature lithiations and Suzuki couplings. The materials exhibit very high nematic phase stability, as determined by optical polarizing microscopy and differential scanning calorimetry. As expected, the optical anisotropy of all the materials is high with values in excess of 0.3 at 25 °C, as measured by refractometry through extrapolation of mixtures in a commercial mixture of low optical anisotropy.


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