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Editorial

Novel molecular materials and devices from functional soft matter

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Soft matter materials exhibit huge responses to external stimuli, altering physical properties directed by internal dynamics. Large scale ordered structures and much lower scale disordered aspects in soft matter can be united to fabricate functional devices and materials. The scope of soft matter science comprises a wide variety of materials such as polymers, gels, colloids, liquid crystals, and biomaterials, opening a way to comprehend their responses to several stimuli from a physical perspective.

The current thrust of soft matter science is aimed at engineering novel molecular materials and fabrication of devices that exploit two or more properties of soft matter structures. These properties may be rheological, electrical, electronic, photo-physical, quantum chemical, or opto-electronic, to mention a few. Ultimately, beyond understanding basic behavior, solving grand challenges for new generations of functional materials demands the ability to control structure–function relationships over many length scales—from the individual molecular building blocks to the macroscopic device. This topical issue aims to provide an inspiring platform for broadcasting recent progresses and advances in the design, simulation, modeling, synthesis, construction, and characterization of soft matter structures for functional materials and devices.

In this topical collection, top researchers have contributed their exemplary work. Madhumohan reported on dielectric relaxations in a liquid crystal along with thermistor application. This work reports synthesis of thermotropic hydrogen bond liquid crystal ClBAO + 6BAO by mixing chlorobenzoic acid and hexyloxybenzoic acid in equimolar ratios. The FTIR analysis reveals hydrogen bond formation between the precursors. This mixture exhibits nematic phase with a large thermal range. The transition temperatures and their corresponding enthalpy values have been obtained from DSC thermograms. Types of relaxations, viz. type 1 and type 2, are recognized and analyzed extensively, showing that they follow Debye relaxation behavior. The intriguing feature of this work is the temperature response of this liquid crystal's resistance. The author claims that this is the first report to notice both behaviors in a mono-mesogen segregated by few degrees of temperature. Detailed discussion on the features of dielectric studies and thermistor applications is presented.

Punyatoya Das et al. reported on UV light sensing and switching applications of two dimeric smectic liquid crystals. Namely, α-ω-bis (4-n-pentylanilinebenzylidene-4′-oxy) butane ($PABO_4$) and α-ω-bis (4-n-pentylanilinebenzylidene-4′-oxy) pentane ($PABO_5$), have been considered for sensing UV light. The molecules discussed in this manuscript present several features, viz., an absorption range that is sensitive to different wavelengths and their usage in flexible devices, offering the prospect for UV sensors. The spectral-associated parameters have been summarized. Further, the switching applications have been explored based on the oscillator strength data in various regions of wavelengths. Vasanthi et al. reported on the impact of core polarity on smectic-B induced hydrogen bond liquid crystals. The novel series of hydrogen bond liquid crystals were synthesized from the 2-methylglutaric acid (MGA) and 4-alkyloxybenzoic acid (nOBA) compounds. The induced smectic B phase with different textures was identified by polarizing optical microscopy. Further, the origination of Sm B phase and its detailed characteristics were reported: due to breaking of in-plane rotational symmetry within molecular layers, smectic B phase is stabilized by suppressing other usual mesophases. Due to the steric effect, and the increased molecular core polarity, the highly stabilized Sm B phase with different textures were observed while varying alkyloxy carbon number $n = 7$ to 12.

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Sharmili et al. published a comparative study on rheometric and stability analysis of additive infused magnetorheological fluids (MRF). The MRF has been utilized in a variety of applications, which nevertheless raise significant concerns regarding sedimentation, due to the density mismatch between the carrier fluid and the suspended magnetic particles. The focus of the study is to determine the efficient incorporation/infusion of such components into the fluid for further applications with sedimentation resistance. The significant repercussion parameters, such as rheology behavior of the samples, temperature, and particle sedimentation, were examined and interpreted. Hari Kishor et al. discussed about a constant current device using hydrogen bond liquid crystals. Electrical, thermal, and spectral characterizations of ferroelectric liquid crystal obtained from the precursors, namely, camphoric acid and heptyloxy benzoic acid, abbreviated as CA + 7BAO. An interesting feature of this work lies in realizing the constant current device with variation to both temperature as well as electrical potential. The same observation shall be utilized for sensitive biomedical instruments.

Jyothy et al. used radical polymerization to create poly (N-isopropyl acrylamide)-co-poly (sodium acrylate) [PNIPAM-co-PSA] hydrogels and analyzed the resulting products. N, N′-Methylenebisacrylamide was employed as a cross-linker, ammonium persulfate as an initiator, and N,N′-isopropyl acrylamide and sodium acrylamide as monomers. Structural analysis was measured by using FT-IR and SEM analysis was used to characterize the morphological structure of the hydrogel. The Taguchi approach was used to study and assess the adsorption studies of the hydrogels for the efficient removal of malachite green (MG) and methyl orange (MO). The results suggest that [PNIPAM-co-PSA] hydrogel can be used as an effective, alternative, and promising adsorbent to be applied in the treatment of effluents containing cationic dyes from wastewater. The synthesis of hydrogels provides a suitable recyclability platform for the adsorption of cationic dyes and allows for their recovery without the use of powerful reagents.

Debajani et al. reported on synthesis of PA-KNNT-P(VDF-HFP) composite films using facile solution casting technique. Due to their wide range of applications in dielectric and electrical systems, phosphonic acid (PA)-modified tantalum-doped potassium sodium niobate (KNNT)–polyvinylidene fluoride co-hexafluoropropylene P(VDF-HFP) composite films have piqued the interest of academic researchers. As a result of their exceptional dielectric and electrical characteristics, PA-KNNT-P(VDF-HFP) composites have the potential to find exciting practical applications in a variety of electronic domains. Jyothy et al. reported on synthesis of polyurethane (PU)-based xerogels using the bio-based polyol derived from chaulmoogra seed oil. Central composite design for four variables and three levels, with response surface methodology (RSM), has been used to get a second-order polynomial equation for the percentage of dye removal. Increase in the pH and quantity of the adsorbent was found to increase the sorption capacities of the xerogel (NC-PUXe) toward rhodamine B maximum adsorption.

Vidya et al. addressed the need for dynamic memory with high density. In this work, an investigation on existence of dynamic memory feature in a frequency tuned homologous series of thermotropic liquid crystals has been carried out. The main objective of this work is observation of dynamic memory storage in liquid crystals exhibiting nematic phase, at different frequencies in a thermotropic liquid crystal as the ingredient in a conducting polyamide buffed glass cell excited by an external electrical dc stimulus. Andreeva et al. studied the interaction of associates (dimers and trimers) of 4-*n*-pentyl-4′-cyanobiphenyl (5CB) with 1,2-diamino-4-nitrobenzene and *N*,*N*-dimethyl-4-nitrosoaniline dye molecules. The electronic absorption spectra of dyes are sensitive to the structure of the mesophase. The pattern of the spectrum changes depending on the structure of the complex of the dimer or trimer with the dye molecule. The long-wavelength transition bands are characterized by shifts that are bathochromic for 1,2-diamino-4-nitrobenzene and hypsochromic for N, N-dimethyl-4-nitrosoaniline. Ashok Kumar et al. reported on Collective modes, relaxations, de Vries behavior, and field influence in SmA and SmC^*_{deVr} phases of chiral liquid crystal dimer C-10Bms with siloxy spacer. Relatively enhanced thermal range of LC phases in dimer configuration was detailed.

The present topical issue reports a few exemplary works on novel molecular materials and devices from functional soft matter. The researchers in this topical issue proposed and carried out their studies on novel molecules; hence, the issue opens and offers a platform to design novel materials and devices.