Advanced Functional Liquid-Crystalline Materials

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Supramolecular self-assembly of liqiud-crystalline (LC) molecules has attracted much attention because a varitey of advanced functions of transport, information, sensing, acturation, photofunction, and biofunctions can be induced due to these dynamic and self-organized structures. Design of molecular structures and control of molecular interactions are the key to obtain highly functional LC nano-assemblies.[1-7] Here nanostructured functional LC materials are presented in view of design and self-organization of 1D, 2D, and 3D nanostructures. Collaboration of materials design with molecular dynamics (MD)[3,8,9] simulation and advanced measurements[10,11] are also described. For example, smectic LC materials have been applied to 2D nanostructured electrolytes[7,12] and water treatment membranes[3,13]. Stable behavior as lithium ion batteries was observed for the 2D LC electrolytes.[7,12] High virus removal was achieved for nanostructured polymers preserving 2D smectic structures derived from phase segregation.[3,13] Relationships of 1D, 2D, and 3D nanostructures and their advanced functions have been studied by MD simulation and X-ray spectroscopy.[8,9,10,11] For example, 2D phase structures and their transitions of smectic electrolyte moleules are well explained by the results with electron-density maps obtained by X-ray and MD simulations.[9] Moreover, selective properties of subnanoporous water treatment LC membranes have been well explained by soft X-ray emission study of the synchrotron facilities.[11] Liquid crystals have great potential as highly functional soft matter in a variety of fields based on nature of self-organized dynamic structures.

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