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Scalable Directed Self-Assembly and Anisotropic Transport Properties of Soft Mesophases for Membrane Applications[1]

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Self-assembly of block copolymers and surfactant mesophases can be can be utilized in creating composite materials with very fine periodic structures. Easy access to nm-scale features coupled with compositional variety and thus tunable physical properties makes these nanoscale heterogeneous materials excellent candidates for selective transport applications including ion-conduction, ultrafiltration and desalination. A critical limitation in their performance however arises from the tortuosity of randomly oriented self-assembled structures. We show that in appropriately engineered systems, magnetic fields provide a viable route for scalable control of morphology, producing well aligned materials over large length scales. Here we discuss this approach for the fabrication of ion conduction membranes, aligned carbon nanotube membranes and nanoporous films. We quantitatively assess the anisotropic transport properties of one such system and confront the data with models based on effective medium theory and composite conductivity calculations. The results demonstrate that directed self-assembly can provide non-trivial enhancement of the transport properties in these applications.

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