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Tutorial

From Windows to Mars: New Applications of Liquid Crystals

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One of the grand current research challenges is to improve the energy efficiency of residential and commercial buildings, which cumulatively consume more than 40 percent of the energy generated globally. In addition to improving comfort of inhabitants and mitigating the growing energy consumption problem, new building materials and technologies could provide a safe strategy for geoengineering to mitigate the global climate change. This tutorial reviews recent progress in developing such advanced materials using liquid crystalline self-organization for templating order of nanoparticles like nanocellulose, which is often derived from wood or even dirty feedstocks like waste. By using chemical and bacteria-enabled processing, nanocellulose can be used to fabricate broadband photonic reflectors, thermally super-insulating aerogels, solar gain regulators and low-emissivity coatings with potential applications in windows, roofs, walls and other components of buildings envelopes. These material developments draw inspiration from advanced energy management found in nature, such as nanoporous photonic structures that evolved in cuticles of beetles. Fabrication of such materials takes advantage of mesoscale liquid crystalline self-assembly, which allows for predesigned control of cellulose and other nanoparticle orientations at the mesoscale. With the potential fully realized, such materials could one day transform the current energy-lossy buildings into energy plants on Earth and possibly even enable extraterrestrial habitats. For the liquid crystal research field, these new building-related applications present a major beyond-displays opportunity on the applied side of research spectrum.

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