MAR13-2012-020122

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Periodic Polymers

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Periodic polymers can be made by self assembly, directed self assembly and by photolithography. Such materials provide a versatile platform for 1, 2 and 3D periodic nano-micro scale composites with either dielectric or impedance contrast or both, and these can serve for example, as photonic and or phononic crystals for electromagnetic and elastic waves as well as mechanical frames/trusses. Compared to electromagnetic waves, elastic waves are both less complex (longitudinal modes in fluids) and more complex (longitudinal, transverse in-plane and transverse out-of-plane modes in solids). Engineering of the dispersion relation between wave frequency w and wave vector, k enables the opening of band gaps in the density of modes and detailed shaping of w(k). Band gaps can be opened by Bragg scattering, anti-crossing of bands and discrete shape resonances. Current interest is in our group focuses using design - modeling, fabrication and measurement of polymer-based periodic materials for applications as tunable optics and control of phonon flow. Several examples will be described including the design of structures for multispectral band gaps for elastic waves to alter the phonon density of states, the creation of block polymer and bicontinuous metal-carbon nanoframes for structures that are robust against ballistic projectiles and quasi-crystalline solid/fluid structures that can steer shock waves.