Functional nanomechanical metamaterials driven by light, electromagnetic forces and sound

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Abstract: The changing balance of forces at the nanoscale allows a new generation of metamaterials in which electromagnetic forces, thermal stimulation, sound and optical signals can be engaged to dynamically change their optical properties.

In this paper we overview nanomechanical metamaterials individual building blocks of which, the metamolecules and their arrays, are fabricated on elastic dielectric membranes. Such metamaterials can be reconfigured with external stimuli to achieve optical modulation at high frequencies, potentially reaching the gigahertz range. Mechanical and optical resonances enhance the magnitude of actuation and optical response within these nanostructures, which can be driven by electric signals of only a few volts, microwatt optical signals or induced by resonant acoustic vibrations of the metamaterial framework.

Such metamaterial exhibit profound electro-optical, magneto-optical and acousto-optical switching and modulation, optical nonlinearity for modulating light with light, asymmetric transmission, tunable chirality and electrogyration.

We also report a new technique for hyperspectral imaging of picometric Brownian and stimulation movements of the individual building blocks of these functional metamaterials.