Transmission Asymmetry in All-dielectric Opto-mechanical Metamaterials

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We report on the manifestation of transmission asymmetry in nano-opto-mechanically reconfigurable all-dielectric metamaterials.

The reversible structural reconfiguration of photonic metamaterials manufactured on free-standing elastic nano-membranes, under the action of external stimuli, can drive modulation of their optical properties at high (up to GHz) frequencies. Such nano-mechanical metamaterials can be engineered to present substantive electro-, magneto- and acousto-optic switching coefficients; to manifest large effective optical nonlinearities and bistability; and to enable the interrogation and exploitation of optical phenomena that are extremely small, or indeed non-existent, in bulk media.

Resonantly enhanced optical forces generated among the component parts of a free-standing photonic metamaterial can be of comparable magnitude to the elastic restoring forces arising from nanoscale structural deformation. As such, they can be engaged to dynamically reconfigure the structure, providing a mechanism for strong opto-mechanical nonlinearity dependent upon the direction of light propagation, leading to transmission asymmetry at $\mu W/\mu m^2$ intensities.