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Photon-phonon excitations in single acousto-optical microcavities

MARTIN MALDOVAN, EDWIN THOMAS, Massachusetts Institute of Technology — Photonic and phononic crystals are periodic structures, which, for certain wavelengths, exhibit a bandgap that does not allow the propagation of either light (photons) or sound (phonons). These periodic materials can also localize and guide light or sound by means of microcavities and waveguides, or allow for negative refraction and behave like superlenses. Photonic and phononic crystals have been realized individually, although as yet there has been no combined study that exploits their singular properties. We propose the development of a new class of physical system that combines photonic and phononic properties. In this paper, we show novel excitations between photons and phonons localized in the same area at the same time within these novel materials. The simultaneous localization of light and sound creates a strong influence on photon-phonon interactions and we anticipate the realization of a coherent monochromatic source of very high-frequency phonons. Design guidelines are provided for these novel acousto-optical microcavities in terms of structural morphologies and material platforms. This research helps to develop physical mechanisms for light-induced generation of coherent phonons and acousto-optical effects that can result in the optical cooling of materials.

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