Electrically Tunable Collective Modes in a MEMS Resonator Array

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Interaction between light and mechanically vibrating systems was first discussed by Einstein and Bohr. A gedanken experiment of optical diffraction by a vibrating two slit structure was employed to demonstrate the complementarity principle of quantum mechanics. These ideas were later elaborated in order to formulate the theory of x-rays and neutrons diffraction by crystals. In these systems mechanical vibrations due to both thermal and quantum fluctuations strongly modify the diffraction pattern. This allows experimental study of the crystal's normal modes of vibration (phonons) and their dispersion relation. Micro electro-mechanical systems (MEMS) technology allows studying similar phenomena using artificial mechanical systems at mesoscopic length scales. Such studies are motivated not only by scientific interest but rather also by the prospects of developing new micro opto-mechanical devices. This rapidly growing field of research employs MEMS technology to realize a variety of on-chip fully integrated optical devices.

In the present work we use optical diffraction to study the mechanical properties of a periodic array (grating) of suspended doubly-clamped beams made of Au. What is novel and especially interesting about the present work is that our devices allow application of mutual electrostatic forces *between* the beams. This coupling gives rise to the formation of a band of collective modes of vibration (phonons). We excite these collective modes parametrically and employ optical diffraction to study the response. A simple model describing our system is developed and compared with experiment. These structures offer unique prospects for spectral analysis of complex mechanical stimuli.

For more information on this work see cond-mat/0008211.