Radiation pressure for ultrasonic diode and switch effects

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A new strategy to break the transmission symmetry of a system is presented in this work. We make use of the quasi-static deformation of part of a propagation medium originating from the acoustic radiation pressure effect. This deformation, which can occur only for one incidence direction of the ultrasonic waves, leads to a reversible reconfiguration of a multilayer system within several states showing drastic differences in successive impedance mismatches and thus is able to alter drastically the total transmission properties. While most of the existing architectures used to break the symmetry of a system use complex wave phenomena to reach non-reciprocity, such as nonlinear frequency conversion effects, or coupling with time-dependent properties that require the use of external energy, our design and the associated processes do not. The performance of the proposed architecture is studied experimentally, and we demonstrate a giant asymmetric ratio together with a high transmission of acoustic energy in the forward direction, without significant distortion of the signal. Moreover, the proposed architecture is based on a relatively simple design and can operate over a wide range of frequencies. In view of its performance, the concept is also extended to realize and validate experimentally an acoustical switch which demonstrates a transistor effect. This concept and the tested device overcome the identified current limitations of acoustic asymmetric devices and thus creates new possibilities for the further development of original wave-control devices.