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Phononic subsurface: Flow stabilization by crystals[1] MAHMOUD I. HUSSEIN, SEDAT BIRINGEN, OSAMA R. BILAL, ALEC KUCALA, University of Colorado Boulder — Flow control is a century-old problem where the goal is to alter a flow's natural state to achieve improved performance, such as delay of laminar-to-turbulent transition or reduction of drag in a fully developed turbulent flow. Meeting this goal promises to significantly reduce the dependence on fossil fuels for global transport. In this work, we show that phonon motion underneath a surface interacting with a flow may be tuned to cause the flow to stabilize, or destabilize, as desired. This concept is demonstrated by simulating a fully developed plane Poiseuille (channel) flow whereby a small portion of an otherwise rigid wall is replaced with a one-dimensional phononic crystal. A Tollmien–Schlichting (TS) wave is introduced to the flow as an evolving disturbance. Upon tuning the frequency-dependent phase and amplitude relations of the surface of the phononic crystal that interfaces with the flow, the TS wave is shown to stabilize, or destabilize, as needed. A theory of subsurface phonons is presented that provides an accurate prediction of this behavior without the need for a flow simulation. This represents an unprecedented capability to passively synchronize wave propagation across a fluid-structure interface and achieve favorable, and predictable, alterations to the flow properties.

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