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Strongly Nonlinear Waves in Polymer-Based Phononic Crystals

CHIARA DARAIO, VITALI NESTERENKO, ERIC HERBOLD, SUNGHO JIN, University of California, San Diego — "Sonic vacuum" type phononic crystals were assembled from chains of polytetrafluoroethylene (PTFE) beads and Parylene coated steel spheres. It was demonstrated for the first time that these polymer-based "sonic vacui," with exceptionally low elastic modulus of particles, support propagation of strongly nonlinear solitary waves (and their trains) with a speed below 100 m/s for small amplitudes in reasonable agreement with numerical calculations. These solitary waves can be described using classical nonlinear Hertz law despite the viscoelastic nature of the polymers and the high strain rate deformation of the contact area. Elastic modulus for PTFE taken from extrapolated Hugoniot data results in a good agreement with experimentally measured parameters of solitary waves. Tunability of signal shape and velocity was achieved through a non-contact magnetically induced precompression of the chains. This prestress allowed an increase up to two times of the solitary waves speed and a significant delay in signal splitting. This work was supported by NSF (Grant No. DCMS03013220).

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