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Mechanical mode coupling and nonlinearity in as-grown GaAs nanowires FLORIS BRAAKMAN, DAVIDE CADEDDU, University of Basel, GOZDE TUTUNCUOGLU, FEDERICO MATTEINI, DANIEL RÜFFER, ANNA FONTCUBERTA I MORRAL, École Polytechnique Fédérale de Lausanne, MARTINO POGGIO, University of Basel — We demonstrate coupling and nonlinear behavior of transverse mechanical modes of as-grown GaAs nanowires. Because of their small dimensions and potentially defect-free growth, nanowire cantilevers are promising as ultrasensitive force transducers for scanning probe microscopy. Furthermore, nanowire heterostructures can combine functionalities in one integrated structure which makes them attractive as hybrid systems. The observed nonlinearity is used to demonstrate mechanical mixing of two excitation frequencies, as well as to amplify a signal at a frequency close to the mechanical resonance of the nanowire oscillator. The mode coupling is observed both in a pump-probe experiment, where the resonance of one mode is shifted to higher frequencies by pumping the other mode, and in a time-resolved manner in a ringdown experiment, in which case a clear beating pattern with frequency equal to the frequency difference between the two modes is present. Sufficiently strong coupling forms the basis for phenomena such as phonon-cavity physics, mechanically induced transparency and synchronization. Furthermore, the nonlinearity and mode coupling can be used in various amplification schemes for enhancing sensitivity in force microscopy.

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