Modification of the phonon spectrum of bulk Si through surface nanostructuring

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In this paper, we present experimental evidence on the change of the phonon spectrum and vibrational properties of a bulk material through phonon hybridization mechanisms. The phonon spectrum in a finite material is strongly affected by the presence of free surfaces, which is the addition of a contribution from an essentially two-dimensional crystal. The phonon spectrum of a bulk material can hence be altered by a hybridization mechanism between confined phonon modes in nanostructures introduced on the surface of a bulk material and the underlying bulk phonon modes. We measured the heat capacities of bare and surface-structured silicon substrates originating from the same silicon wafer. Then, we deduced important features of the phonon spectra of the samples investigated through a rigorous analysis of the measured heat capacity curves. The results show that the shape and size of the nanostructures made on the surface of the bulk substrate have a strong effect on the phonon spectrum of the bulk material.