A Study of the Vibrational Modes of a Nanostructure with Picosecond Ultrasonics

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We describe experiments in which a sub-picosecond pump light pulse is used to excite vibrations in a nanostructure consisting of a periodic array of copper wires embedded in a glass matrix on a silicon substrate. The motion of the wires after excitation is detected using a time-delayed probe light pulse. From the measured data, it is possible to determine the frequencies Ω_n and damping rates Γ_n of a number of the normal modes of the structure. These modes have frequencies lying in the range 1 to 30 GHz. By comparison of the measured Ω_n and Γ_n, with the frequencies and damping rates calculated from a computer simulation of the vibrations of the nanostructure, we have been able to identify the different normal modes and deduce their vibration patterns.