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Complete characterization in thin film using picosecond ultrasonics and nanostructured transducer

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Picosecond ultrasonics is an efficient method to excite and detect vibrations within a thin film. A strong optical pulse warms a material surface, which leads to the creation of an acoustic wave propagating at the sound velocity. The waves propagation modifies the optical properties of the material that can be detected by a second time-shifted optical pulse. With an usual metallic transducer, only longitudinal waves can be generated. The use of this technique on a nanostructured transducer adds in-plane propagating waves. In the case of an isotropic medium, we have access to all acoustic properties. In order to confirm this statement, we realized and studied 2D lattices of metallic nanostructures. We used e-beam lithography to obtain defect free lattices of aluminium nanocubes. Both cubes width and lattice parameters were chosen to optimize the properties measurements[1]. This nanostructuration allows us to get information about longitudinal and in-plane waves, in the gigahertz frequency range. The experiments where carried out with an aluminium lattice on a 600nm-thick silica film. This method, demonstrated on a well-known material, is suitable for any thin film.

[1]J.-F. ROBILLARD , A. DEVOS and I. ROCH-JEUNE " Time-resolved vibrations of two-dimensional hypersonic phononic crystals ", Phys. Rev. B. 76, 092301 (2007)