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Imaging of 3D acoustic wave-fronts by means of picosecond laser ultrasonics in GaAs substrate

Emmanuel Péronne[a], Laurent Belliard[a], Shuo Zhang[a], Clément Rossignol[b] and Bernard Perrin[a,c]
[a]INSP - UMR 7588 CNRS & Université Pierre et Marie Curie, 140 Rue de Lourmel, 75015 Paris, France
[b]LMP, UMR CNRS 5469, Université Bordeaux I, 351, cours de la Libération, 33405 Talence, France
[c]Laboratoire des Milieux Désordonnés et Hétérogènes, Université Pierre et Marie Curie, UMR 7603 CNRS, 4 Place Jussieu, 75252 Paris, France

Picosecond ultrasonic experiments are widely used as pump-probe technique using longitudinal acoustic pulses and measuring time dependence of the signal. We present an experiment which combines an interferometer with the control of the pump-probe spatial overlap. Such set-up can perform a new kind of bulk phonon imaging based on ultrafast optical generation and detection scheme. When ultrafast acoustic longitudinal wave propagate in crystals they generate coherent transverse acoustic wave by diffraction. Transverse waves are known to give rise to phonon focusing patterns. The imaging of such patterns in time and space allowed us to partially reconstruct the wave front surface of bulk acoustic wave in crystals. The data may be viewed as 2D slices of the 3D acoustic wavefront revealing the basic anisotropy of the solid with unprecedented micronic lateral and in-depth resolution. Measurements are carried out in a 356 μm-thick GaAs sample as an example, but many different experimental conditions are compatible with the present set-up. This technique provides a new way to perform phonon energy and phonon polarisation dependent experiment with high frequency phonons.