Advances in Applications of Picosecond Acoustic Interferometry for Nanoscale Imaging

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Picosecond acoustic interferometry, also known as time-domain Brillouin scattering, is an experimental technique that uses ultrafast lasers for generation and detection of nanometer-scale coherent acoustic pulses with picosecond scale time duration. Detection involves interfering two probe light pulses: one scattered by acoustic nanopulse propagating in transparent materials, and one reflected from stationary interfaces of the sample. Transient optical reflectivity recorded by a photodetector, as the acoustic nanopulse propagates, contains information on local acoustical, optical, and acousto-optical parameters of the material. Picosecond acoustic interferometry imaging is based on Brillouin scattering and has potential to provide all information that researchers in materials science, physics, chemistry, biology, etc., could get with classic frequency-domain Brillouin scattering. It can be viewed as a replacement for Brillouin microscopy in all investigations where nanoscale spatial resolution is required. Picosecond acoustic interferometry has been already applied for imaging of nanoporous films, ion-implanted semiconductors/dielectrics, grain boundaries, metal-epoxy interfaces, vegetable and animal cells, texture in polycrystalline materials, temperature distributions in liquids, and for monitoring the transformation of nanosound caused by absorption, diffraction, nonlinearity, and focusing. The first applications of shear acoustic waves in imaging based on picosecond acoustic interferometry have been reported. The theory of such imaging technique suggests multiple perspectives for its further development.