Picosecond Lattice Dynamics Probed by Time- and Angle-resolved X-ray Diffraction

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Fast time-resolved X-ray diffraction using intense pulsed X-ray sources such as synchrotron radiations (SRs) has enabled us to take a "snapshot" of atomic arrangements in transient states produced by ultrashort pulse laser irradiation. So far, we have been developed a picosecond pump-probe system at the SPring-8 undulator beamline by synchronizing a mode-locked laser and the SR pulses [1]. By the synchronization system, the transient lattice expansion of gallium arsenide crystals by the laser irradiation has been observed, and was applied to switching of X-ray SR pulses [2].

Here, we report the acoustic phonon oscillations near the surface of a GaAs crystal observed by employing the 40 ps time-resolved X-ray diffraction, combined with angle-resolved measurement of an X-ray beam diffracted in asymmetric geometry.

The experimental results show that femtosecond laser irradiation generates the longitudinal acoustic phonon and lattice expansion along the surface normal. By decomposing the time-dependent angular distribution of diffraction into peak shift and oscillatory part, acousto-optic effect was clearly observed as out-of-phase GHz-oscillations at sidebands around the principal peak shifted due to the lattice expansion.

[1] Tanaka Y., Hara T., Kitamura H., Ishikawa T., *Rev. Sci. Instrum.*, 2000, **71**, 1268. [2] Tanaka Y., Hara T., Yamazaki H., Kitamura H., Ishikawa T., *J. Synchrotron Rad.*, 2002, **9**, 96.

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