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Laser driven THz coherent phonons in β-MnAs probed by time-resolved x-ray diffraction

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MnAs is a semi-metal with potential for applications in the fields of magnetocalorics, spintronics and laser-driven magnetization reversal. The interest for MnAs stems from a peculiar sequence of phase transitions that are not fully understood yet. The low temperature structure is hexagonal and ferromagnetic (α-MnAs). At 313 K, ferromagnetic order is lost and the structure becomes orthorhombic (β-MnAs) in a first order phase transition. The orthorhombic distortion parameter η decreases progressively through a second-order phase transition and vanishes at 400 K, where hexagonal symmetry is recovered (paramagnetic γ-MnAs). Recent DFT calculations suggest that the β-γ transformation is a displacive phase transition driven by the softening of a THz mode with normal coordinate along η [1].

We investigated the structural dynamics of laser excited MnAs/GaAs(001) films using time-resolved x-ray diffraction at the LCLS FEL source [2]. The temperature dependent intensity oscillations of several Bragg reflections allow us to identify the optical phonon associated with the orthorhombic distortion in the β-phase and to follow its softening as the distortion vanishes on the path towards the hexagonal symmetry. The frequency of this mode falls in the THz range, in agreement with DFT calculations.

[1] J. Lazewski et al., Phys. Rev. Lett. 104, 147205 (2010); Phys. Rev. B 83, 054108 (2011).

[2] F. Vidal et al., Phys. Rev. Lett., accepted

Choix de session parallèle

6.4 Résultats scientifiques récents obtenus avec les XFEL

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