Experimentelle Physik 2

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Anisotropic photostriction and deformation potentials in perovskite semiconductors.

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Perovskite semiconductors attract attention due to their intriguing optical and electrical properties with huge potential for photovoltaic and light emitting applications. Spectroscopy of coherent acoustic phonons employs excitation and detection by short femtosecond laser pulses in pump-probe techniques, representing a powerful method to investigate the lattice dynamics in a wide material spectrum. This method exploits excitation of ultrafast stress associated with the thermoelastic coupling in metals or with the photostriction in semiconductors. In most settings, only the longitudinal acoustic (LA) phonons are generated. The methods to induce transverse acoustic (TA, shear) phonons are excitation at the crystalline surface of low symmetry [1] and the inverse piezoelectric mechanism [2] fail in centrosymmetric halide perovskites, where the mechanisms of efficient generation of shear acoustic waves are still under debate.

In [3], the efficient optical generation of shear strain in perovskite semiconductors via the giant anisotropic photostriction of the tetragonal crystal lattice is revealed and elaborated. Coherent TA phonons with amplitudes comparable to the LA modes are observed in the tetragonal phase of a Cs2AgBiBr6 crystal using time-domain Brillouin spectroscopy by femtosecond laser pulses. Only one of the two TA modes is excited whose polarization direction is given by the projection of the *c*-axis on the sample surface. In cubic phase only LA strain pulse is generated. The weak temperature dependence of the photogenerated coherent phonons provides evidence for the non-thermal nature of the effect, i.e., for the photostrition.

To further elaborate the microscopic origin of the giant anisotropic photostriction, the DFT calculations were performed. The calculations reproduce different sign of photostriction in teteragonal phase of CsPbI3 [4] and predict similar effect in teteragonal double perovskite Cs2AgBiBr6. Calculations of deformation potentials demonstrate the essential importance of the optical deformation potential of the mode associated with halide octahedra rotation mode in Γ-point.U. L. Andersen, T. Gehring, C. Marquardt, and G. Leuchs, Phys. Scr. **91** 053001 (2016).

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