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Chiral-Phonon–Driven Ultrafast Spin Currents in a Non-Magnetic Ferroelectric

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Chiral phonons are a fundamental lattice vibration involving atoms moving in a circular motion, allowing the phonons to carry angular momentum [1]. This angular momentum allows for non-magnetic materials to exhibit properties previously only observable in magnetic materials. Here we present data showing that a non-magnetic ferroelectric material, In_2Se_3, can generate an ultrafast spin current through a chiral-phonon induced spin-Seebeck effect [2]. By adding a thin heavy metal layer, we utilise the inverse spin-Hall effect to convert the spin current in the In_2Se_3 layer into a transient charge current, which emits a pulse of terahertz radiation, similar to ferromagnetic terahertz spintronic emitters [3], but without the need for an external magnetic field. These emitted pulses were measured using polarisation resolved terahertz emission spectroscopy, revealing a strong elliptical polarisation, with the handedness being controlled by the polarisation of the optical pump beam. This indicates coherent transfer of phonon angular momentum on femtosecond timescales. This emission mechanism shows promise for developing circularly polarised terahertz emitters with controllable handedness, as well as a pathway for generating spin currents in non-magnetic materials.

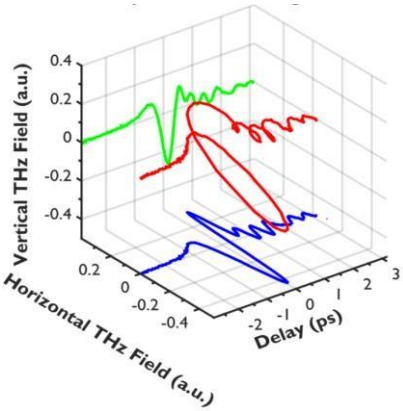

Fig. 1 Measured horizontal and vertical polarisation of a terahertz pulse emitted from In_2Se_3 with a layer of Pt.

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