Hybrid perovskites based photoconductive THz pulse emitters and detectors.

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The main properties of halide perovskites useful for solar cells make them also attractive for terahertz (THz) applications. This class of materials, well studied in the optical range, remains much less studied in the THz range. Meanwhile, increasing the efficiency of pulsed terahertz sources and detectors due to more advanced designs or new materials is one of the main directions in the field of terahertz technologies.

Here, we experimentally demonstrate the first attempt to apply solution-processed polycrystalline films of hybrid perovskites for the development of photoconductive terahertz emitters and detectors. By using polycrystalline films and single crystals of widely studied methylammonium-based perovskites $MAPbI_3$ and $MAPbBr_3$, we fabricate and characterize large-aperture photoconductive antennas [1]. The combination of ultrafast time-resolved spectroscopy and terahertz emission experiments allows us to determine the still-debated room temperature carrier lifetime and mobility of charge carriers in halide perovskites using an alternative noninvasive method. The ultrafast change of conductivity that occurs in single crystals and polycrystalline films of lead methylammonium halides excited by a femtosecond laser both above and below the bandgap enables efficient emission and detection of THz radiation [2]. Under excitation with 40 fs pulses centered at 400 nm the fabricated perovskite photoconductive detectors in the frequency range of 0.1-2 THz demonstrate detectivity comparable to traditional detectors based on electro-optical sampling in nonlinear crystals [3].

The results demonstrate the viability of solution-processable halide perovskite for the fabrication of photoconductive THz antennas and the further development of scalable and cost-effective sensor manufacturing for THz time-domain spectroscopy, imaging, and other photonic THz devices.

[1]. P. Obraztsov, D. Lyashenko et al. Commun Phys 2018, 1, 14.
[2]. P. Obraztsov, V. Bulgakova et al. Nanomaterials 2021,11, 313.
[3]. P.Obraztsov, P.Chizhov et al. ACS Photonics 2022, 9, 1663.