Phonon-driven giant terahertz photovoltaic effect in ferroelectric semiconductor SbSI

Quantum geometry of Bloch electron in crystalline solids produces various exotic quantum phenomena. The shift current photovoltaic effect driven by the photo-creation of quasi particle is one such emerging example that enables the conversion from terahertz photon into DC charge current with absence of dissipative photo-carrier. Among wide-ranging potential applications, however, the fundamental nature of terahertz photovoltaic response has remained elusive. Here, we show the giant photocurrent generation driven by terahertz phonons (< 10 meV) in ferroelectric semiconductor SbSI with the electronic bandgap of 2.3 eV (Fig. 1). Terahertz zero-bias photocurrent is found to be resonantly enhanced by both the soft phonon associated with the ferroelectric transition and the normal optical phonon. Furthermore, the photocurrent efficiency of soft phonon is larger than that for the direct band gap transition and is comparable to the electronic shift current in Weyl semimetal TaAs. The theoretically predicted scaling-law of terahertz shift current and first-principles calculation reasonably explain these observations. The present work establishes the universality and high efficiency of phonon-driven shift current, opening the pathway to novel terahertz technology based on quantum geometry.

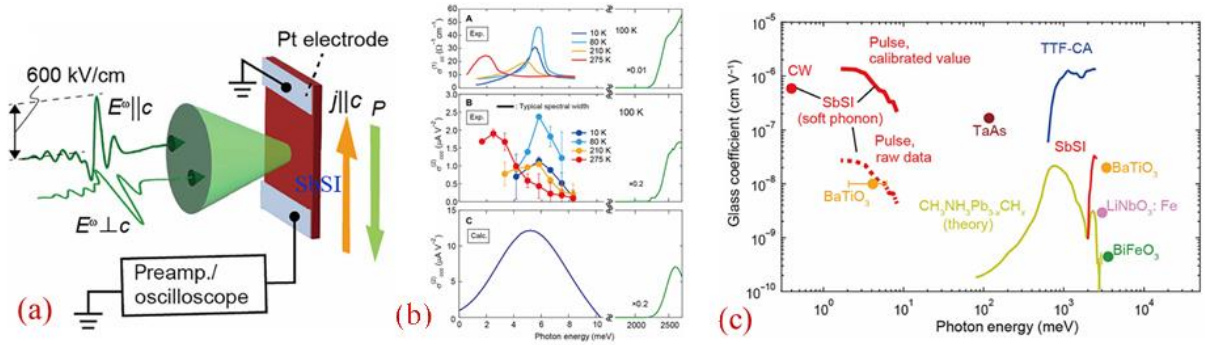

Fig. 1 (a) Illustration of experimental setup of phonon-induced bulk photovoltaic (BPVE). (b) Measured and calculated linear and nonlinear optical conductivities. (c) Overview of photovoltaic performance (Glass coefficient) of various polar materials.

[1] Y. Okamura, G.-Y. Guo, Y. Kaneko, M. Nakamura, M. Sotome, N. Ogawa, M. Kawasaki, Y. Tokura and Y. Takahashi, Large terahertz photovoltaic effect enhanced by phonon excitations in ferroelectric semiconductor SbSI, *Sci. Adv.* **12**, eadw9796 (2026) (https://www.science.org/doi/10.1126/sciadv.adw9796).