THz Nonlinearity Excited with Nanometer Resolution

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Terahertz (THz) nonlinear optics offer powerful tools to investigate and manipulate electronic dynamics in advanced materials, such as emerging 3D Dirac semimetals with massless charge carriers and macroscopic thickness. Although THz scattering near-field optical microscopy (THz s-SNOM) with subdiffraction limit spatial resolution and remarkable field enhancement can provide new insight into efficient Terahertz nonlinearity in nanoscale, exploring nanoscopic THz Nonlinear optics (NLO) still remain challenging due to the universally adopted low excitation power with the high repetition for near-field demodulation. Here we achieve the efficient THz third harmonics generation from the Cd3As2 film in near field by constructing an intense THz s-SNOM system that combines high peak power THz pulses emitted from two-color femtosecond laser filaments with a tapping mode AFM system. The power-law dependence of the THz harmonics and theoretical calculation reveals a convincing third harmonic generation that attributed to the nonequilibrium intraband dynamics driven by the strong THz pulses. Additionally, the near-field third harmonic imaging with resolution of 200 nm, that is nanoscopic near field THz third harmonic generation (THG) of 3D Dirac semimetal are demonstrated. These findings can provide insights for nonlinear currents of Dirac fermions driven by the localized terahertz field and deepen our understanding of the nonlinear interaction between Dirac semimetal and THz waves in near field, paving the way toward novel devices for high-speed electronics and photonics based on topological semimetals.