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Generation and control of the Raman active phonon mode in Bismuth Telluride nanofilm with sub-picosecond THz radiation

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Intense picosecond terahertz radiation has opened new opportunities in solid-state physics and materials science, allowing to probe and/or control different degrees of freedom of a solid by driving electrons, magnons, or phonons at ultrafast timescales with an intense electric field associated with photon energy in the meV range¹. Owing to significant spectral weight in the terahertz (THz) frequency range and the momentum conservation, THz radiation can be directly coupled to high-frequency optical phonons (1-40 THz range), while other phonon modes can be also excited as a result of nonlinear interaction². However, despite numerous reports on optical phonon generation with THz light, there are still some debates on the driving optical phonon generation mechanisms, possibly originating from the non-linear ionic Raman scattering³ or THz sum frequency excitation⁴.

Here, we conduct an experimental study on a well-known thermoelectric compound and topological insulator, 16nm thick semimetal Bi₂Te₃ film, grown by the molecular beam epitaxy on the mica substrate. To study the coherent optical phonon dynamics, the sample was excited with pulsed, high-peak (up to 300 kV/cm) field THz radiation, and we measure the change in the 400 nm probe beam transmittance in a pump-probe geometry. In this work, we report the controlled excitation of 1.85 THz A¹_{1g} Raman active optical phonon with THz radiation having a central frequency in the range of 0.53-0.72 THz. From the notions of the transient phase and THz field strength – optical phonon amplitude dependence, we then try to identify the various pathways of the A¹_{1g} mode excitation with pulsed THz radiation.

Bibliography:

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Topics

Session A. Physics of condensed matter and spectroscopy

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