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Using terahertz spectroscopy to investigate optical phonons in PbTe thin films

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Abstract

The advent of modern experimental techniques using radiation in the terahertz (THz) band of the electromagnetic spectrum – enabled primarily due to the recent advances in THz generation and detection technologies – has been of great interest to the study of a wide variety of condensed matter systems. In fact, among the many THz compelling properties, one can highlight its photons with energies in the milli-electron-volt range, thus making this band suitable for investigating low-energy excitations in materials. Further, one of the powerful techniques based on this radiation is the so-called terahertz time-domain spectroscopy (THz-TDS) [1], which remarkably allows the simultaneous determination of both amplitude and phase information of picosecond THz pulses transmitted through samples. In this work, we report the use of a THz-TDS setup – recently built in our laboratory – for investigating PbTe thin films, expected to show a soft transverse optical phonon mode in the THz frequency range [2]. A brief description of the experimental apparatus is presented, as well as temperature-dependent measurements. Indeed, absorption results in the few THz range have revealed a behavior compatible with a phonon mode softening with decreasing temperature. Moreover, results of phonon magnetic moment up to 30 T are also discussed.

References

[1] J. Neu, and C. A. Schmuttenmaer, Journal of Applied Physics **124**, 231101 (2018)

[2] A. Baydin, F. G. G. Hernandez, *et al.*, Phys. Rev. Lett. **128**, 075901 (2022)

Figures

Figure 1: Transmittance of a 300nm PbTe thin film in the few terahertz range measured by the THz-TDS technique. The characteristic absorption behavior indicates the softening of the transverse optical phonon mode with decreasing temperature.