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Investigation of thin bismuth and tellurium layers using THz pulse excitation spectroscopy

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Two-dimensional or other thin materials have high potential for use in next-generation electronic and optoelectronic devices. Recently, bismuth and tellurium have attracted considerable interest due to their broad applicability prospects. Although characterisation of thin layers presents a significant challenge the use of THz excitation spectroscopy can be employed to determine several electronic properties.

Thin bismuth films of various thicknesses between 5 and 32 nm grown by molecular beam epitaxy on Si(111) substrates have been investigated. Due to the 2D confinement, the electron energy band structure depends on the thickness. Using terahertz excitation spectroscopy (Fig. 1), the direct band gap was found to be in the range of 0.25 to 0.5 eV - much larger than the indirect band gaps of the films. A simple model was used to describe the nature of the THz emission from these films, which is caused by uncompensated lateral photocurrents due to diffusive electron scattering at the Bi/Si interface.

Furthermore, 150 nm and thinner layers of tellurium were produced using two distinct techniques: deposition on multiple substrates from a chemical solution and thermal evaporation in a vacuum. The mobility and lifetime of the layers obtained through chemical deposition were higher to the values observed in thermally evaporated Te layers. Potential application in various THz photonics components and fast infrared photodetectors is possible for these thin tellurium layers..

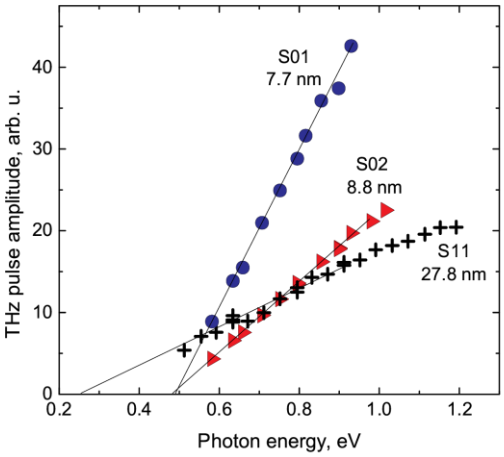

Fig. 1 THz excitation spectra of several different thickness bismuth layers

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