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Non-contact characterization of HgCdTe films with terahertz time-domain spectroscopy

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Mercury cadmium telluride ($Hg_{1-x}Cd_xTe$ or MCT) is a tunable bandgap semiconductor with an long history as a premier infrared detection material. High-quality epitaxial films of $Hg_{1-x}Cd_xTe$ can be grown with continuous Cd fractions ranging from x = 0 to 1. MCT alloys are of special interest because by changing the alloy composition one can efficiently tune the band gap from positive till negative going through zero at critical alloy composition (x ~ 0.165, T ~ 4 K). It is well known also that the decrease of the energy band gap is correlated with decrease of the effective mass (increased tunability). One should mention that the band gap can also be efficiently tuned by temperature or hydrostatic pressure [1].

Early, we have demonstrated terahertz cyclotron emission in these materials (MCT with different x near critical value of zero-gap state) [2]. The existence of sizeable cyclotron emission is directly related to the particular LL spectrum, which comprises only non-equidistantly spaced levels. Typical energy transitions in narrow-ap semiconductors and scattering rates of free carriers in high-mobility semiconductors lie in the few-terahertz (THz) range, which is near the limit of many far-infrared spectroscopy systems. THz time-domain spectroscopy (THz-TDS), lying at the lowest frequency end of the far-infrared regime, but above microwave frequencies, has been established as a powerful broadband, non-contact probe of transport and the complex dielectric function in a variety of materials. THz spectroscopy presents several advantages over other non-contact probes of conductivity. With THz-TDS, the direct sampling of the THz electric field waveform in the time-domain enables direct observation of the complex conductivity spectrum. Here we study bulk MCT with different Cd alloys and discussed different methods of characterization of narrow gap materials.

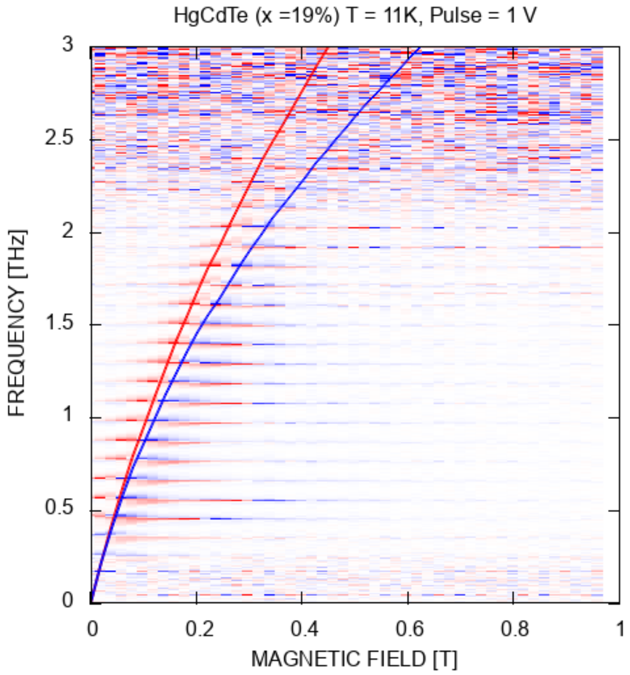

Fig.1 Time-domain measurements of the THz reflection as a function of magnetic field MCT.

REFERENCES

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