Response of InSb at sub-THz and THz frequencies

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Bulk Indium Antimonide has been used as an ultra sensitive detector of millimeter and sub-millimeter waves. A response of the detector at magnetic fields is based on intra Landau or inter Landau levels transitions. In the former case, it behaves as a non-resonant detector, in the latter - as a resonant one. In conditions of the resonant response, when it is placed at high enough magnetic field B, it strongly reacts only for radiation with frequency close to that of the cyclotron resonance $\omega_c = eB/m$. Then, it can be used to characterize unknown sources of radiation as it is, e.g., in a Landau - emission spectrometer described in [1]. There was a common belief that at strong magnetic fields, when the conduction band of InSb is quantized into Landau levels, a response of an InSb detector can be only the resonant one. Our experiment shows that this is in fact not the case and a strong resonant response, resulting from heating of the electron gas within one Landau level, can be osberved at strong magnetic fields.

The experiments were done on a detector of InSb fabricated in a meander shape on a sapphire tapered substrate. The detector was kept at about 4 K in a helium exchange gas in the centre of a superconducting coil. A radiation was guided to the detector with an oversized metallic waveguide (a stainless steel tube of a diameter of 12 mm). A backward wave oscillator with frequency multipliers and an optically pumped molecular laser served as sources of radiation. They allowed to measure a response of the detector as a function of B in the frequency f range 0.1 THz $< f <$ 3 THz. Measurements were carried out in a constant detector current or a constant detector voltage bias conditions and the detector signal (a photoresistance or a photocurrent, respectively) were measured with a lock-in technique. Due a strong magnetoresistance of the detector, a B-dependence of the measured signal is very different for these two biasing conditions. However, both types of measured signals obviously lead to the same dependece of photoconductivity on B, $\Delta\sigma(B)$.

We have found that signatures of the cyclotron resonance are evident only for $f \gtrsim$ 0.5 THz (a resonant detection) and for any f one observes a $\Delta\sigma$ signal which decreases monotonically with increasing B (a nonresonant signal resulting from heating electrons within one Landau level). This nonresonant signal is particularly strong at constant voltage bias conditions but has nothing to do with cyclotron resonance transitions.

We conclude that an InSb detector cannot be used to spectrally characterize uknown sources of THz radiation unless one is sure that the detected radiation is of a frequency higher than about 0.5 THz, as it was always the case in experiments described in [1]. If this cannot be assured, one can erroneously interpret a signal at high B as resulting from a cyclotron resonance transition, while it is due to a nonresonant response.

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[1] W. Knap *et al.*, *Rev. Sci. Instrum.* **63**, 3293 (1992).