HIGH POWER THZ SPECTROSCOPY IN STRONG MAGNETIC FIELDS

D. Kamenskyi[1,2]

[1]*High Field Magnet Laboratory (HFML-EMFL),Radboud University, 7 Toernooiveld, Nijmegen, 6525ED, Netherlands*
[2]*FELIX Laboratory, Radboud University, 7c Toernooiveld, Nijmegen, 6525ED, Netherlands*

e-mail: d.kamenskyi@ru.nl

Recent development of the connection between Free Electron Laser (FEL) THz-radiation source (FELIX laboratory) and High Magnetic Field Laboratory at Radboud University opens new opportunities for the infrared and THz spectroscopies in high magnetic fields. In this talk, I am going to discuss first experimental results obtained using this unique combination and possibilities of the further development.

The FELIX Laboratory exploits intense, short-pulsed infrared and THz free electron lasers. The four lasers FELIX-1, FELIX-2 and FLARE each produce their own range of wavelengths and together, they provide a tuning range between 3 and 1500 µm. Recently, the 90m-long evacuated, quasi-optical transport line with 41 gold-coated mirrors was built to couple the lasers to the high – field Bitter magnets which generate fields up to 33 tesla [1]. To demonstrate the advantages of this setup, I'll give a couple of example of THz studies of semiconductors.

For instance, we study the THz response of the p-doped germanium at high radiation intensities. The transmission spectra of Ge samples with relatively low Ga doping concentration of $2\text{-}3*10^{14}$ cm^{-3} were measured at 1.5 K. The THz response of this compound was investigated in two steps. Because the fundamental absorption lines of Ga acceptor in Ge lie between 1.6 and 3 THz, firstly, we studied the behaviour of the impurity levels in the magnetic fields up to 30 T by means of linear FTIR spectroscopy. We found the Zeeman splitting of the impurity levels is quite similar to the reported earlier for the boron doped germanium [2]. Importantly, the absence of the cyclotron resonance absorption indicates very low number of free carriers in the conduction bands at 1.5 K.

The further high power experiments were performed using monochromatic FEL radiation with frequencies below the lowest impurity level, namely 0.8 and 1.1 THz, to eliminate influence of the Ga intracenter transitions. We find that THz radiation of high intensity promotes very efficiently charge carriers up to the high energetic conduction bands. I will discuss several possible mechanisms of this free carriers generation (replenishment mechanism, free carrier absorption, cyclotron resonance absorption etc).

[1] M. Ozerov *et al*. Appl Phys. Lett. 110, 094106 (2017)
[2] R. E. M. Vickers *et al*. Phys. Rev. B 77, 115212 (2008)