Terahertz dynamics of high-density two-dimensional magneto-excitons

Qi Zhang[1] and Junichiro Kono[1-3]

[1]Department of Electrical and Computer Engineering,
[2]Department of Physics and Astronomy, and
[3]Department of Materials Science and NanoEngineering,
Rice University, Houston, Texas, U.S.A.
Corresponding Author: kono@rice.edu

Electron-hole (*e*-*h*) pairs in semiconductors can be driven through a Mott transition from an insulating excitonic gas into a metallic *e*-*h* plasma by density-dependent Coulomb interactions. Theoretical studies suggest that these interactions can be strongly modified by an external magnetic field, predicting that exciton-exciton interactions should completely vanish in the high magnetic field limit in two dimensions, due to an *e*-*h* charge symmetry, which results in ultrastable magneto-excitons. Here, we present a systematic experimental study of *e*-*h* pairs in photo-excited undoped GaAs quantum wells in perpendicular magnetic fields up to 10 T using optical-pump terahertz-probe spectroscopy. We simultaneously monitored the intra-excitonic 1*s*-2*p* transition (which splits into the $1s\text{-}2p_+$ and $1s\text{-}2p_-$ transitions in a magnetic field) and the cyclotron resonance of unbound electrons and holes as a function of temperature, *e*-*h* pair density, and magnetic field. Typical photo-induced dynamic conductivity data taken at 9 T at various temperatures and pump powers are shown in Fig. 1. We found that the $1s\text{-}2p_-$ feature is robust even under high excitation fluences, indicating magnetically enhanced stability of excitons. Using data taken under both resonant and non-resonant excitation conditions, we will discuss the Mott physics of magneto-excitons.

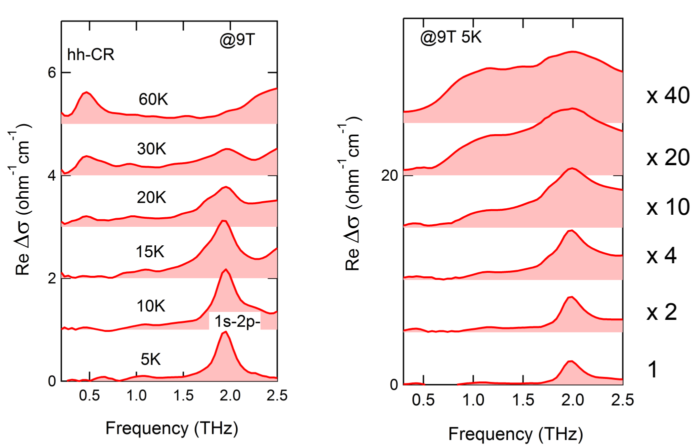

Figure 1- Photo-induced THz dynamic conductivity spectra for an undoped GaAs quantum well sample in a magnetic field of 9 T at various temperatures (left) and pump powers (right).