Effective g-factors in InAs 2DEGs from THz magneto-photoresponse

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Understanding the effects of spin-orbit interaction in narrow gap semiconductor structures is of interest for both fundamental physics and potential spintronic applications. We have used THz magneto-photoresponse and magnetotransport measurements to probe the high quality 2DEG in a narrow InAs quantum well. Under illumination from several lines of an optically pumped THz laser, the magnetophotoresponse associated with cyclotron resonance (CR) appears in each case as an envelope of the amplitude of the Shubnikov-de Haas oscillations of the 2DEG with a peak near the CR field.[1] We simulated the PR data by a model of resonant carrier heating using the expression for the longitudinal resistivity of a 2DEG and taking the difference between $R_{xx}(B,T)$ in the presence of a resonant temperature profile (laser-on condition), and that with a constant background temperature (laser off) to represent the PR signal. An example of experimental data and a simulation is shown in Fig. 1. In this case there are <u>two</u> magneto- absorption features near CR (inset) – the lower field feature is CR; the origin of the upper feature is not presently understood. The simulations incorporate two lines at the corresponding positions, and both clearly influence the envelope of the oscillations. Clear spin-splitting of the PR oscillations is observed for B > 2.5 T. The SdH oscillations do not show resolved spin-splitting at this carrier density until about 4 T. The photoresponse, a differential temperature electron bolometer effect, generally enhances the visibility of the S-dH oscillations at low fields and the spin–splitting at higher fields. Simulations yield the carrier density, the CR effective mass, scattering times and the g-factor. In the present case for n = 8.84 x 10^{11} cm^{-2}, m* = 0.039 m_e and g = -16, the latter greatly enhanced from the single particle value for this confinement and density, apparently due to many-electron exchange effects. We have also fabricated QPCs in these structures (Fig. 2) using micro-laser photolithography and wet chemical etching, and we will also present PR results for these structures. Work at UB supported by NSF MWN DMR 1008138.

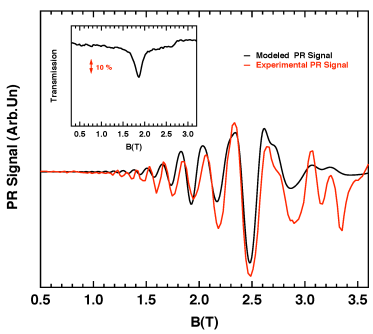

Fig. 1. PR signal at 5.8 meV and 1.8 K vs. B (red) and simulation (black). Inset: magnetotransmission vs. B .

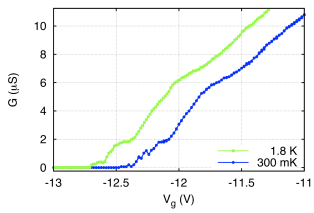

Fig. 2. Conductance vs. in-plane gate voltage showing quantized steps.

[1] M Pakmehr, V. Whiteside, N. Bhandari, et al., Proc. of HMF-20, IOP Journal of Physics:Conference Series, accepted (2012).