Introduction

We carried out a systematic cyclotron resonance (CR) measurements by using Fourier transform infrared spectroscopy in constant magnetic fields to probe the basic characteristics of InMnSb alloy, the newest III-V ferromagnetic structure \cite{1}. In spite of its low Curie temperature, InMnSb has significant potential for application in infrared spin photonics and in spin transport devices due to its lighter holes, small energy gap, and much higher carrier mobility than in other III–Mn–V ferromagnetic semiconductors. The samples were grown in the group of Prof. Wojtowicz and Prof. Furdyna (University of Notre Dame) using molecular beam epitaxy. Since these structures are grown at low temperatures usually they have low carrier mobilities and a very high magnetic field is necessary to observe CR (i.e., $\omega_c \tau > 1$). CR is a direct and accurate method for determining the effective mass (i.e., the curvature of the energy dispersion) of carriers and therefore the nature of the carrier states.

Experimental

We studied four InSb based samples grown on GaAs substrates with the following structures:
1. InMnSb (0.23 $\mu$m)/LT-InSb (0.1 $\mu$m)/CdTe (4.5 $\mu$m), 2.8% Mn content, $p \sim 2 \times 10^{20}$ cm$^{-3}$, $\mu \sim 100$ cm$^2$/Vs.
2. InMnSb (0.23 $\mu$m)/LT-InSb (0.1 $\mu$m)/CdTe (4.5 $\mu$m), 2.0% Mn content, $p \sim 2 \times 10^{20}$ cm$^{-3}$, $\mu \sim 100$ cm$^2$/Vs.
3. Non ferromagnetic: InBeSb (0.23 $\mu$m)/LT-InSb (0.1 $\mu$m)/CdTe (4.5 $\mu$m), $p \sim 1.4 \times 10^{20}$ cm$^{-3}$, $\mu \sim 170$ cm$^2$/Vs.
4. Non ferromagnetic: LT-InSb (0.23 $\mu$m)/CdTe (4.5 $\mu$m). $n \sim 2 \times 10^{18}$ cm$^{-3}$, $\mu \sim 1000$ cm$^2$/Vs.

We used a 33 Tesla resistive magnet along with the FTIR setup of Dr. Yong-Jie Wang as the infrared source to perform systematic photon-energy dependent CR measurements at 4.2 K. A Si-Bolometer was used to detect the transmission signals. Unlike an earlier measurements on InMnAs heterostructures with a similar Hall mobility but lower carrier concentration, we did not observe CR in these samples. As shown in Fig.1, only in the fourth sample, we observed some features but their positions did not change as a function of magnetic field and are most likely due to phonons of InSb.

![Figure 1: Normalized transmission as versus photon energy at different fixed magnetic fields for the n-type InSb film.](image)

In order to increase the possibility of observing CR in these structures, we plan to grow and study samples with lower carrier concentrations to decrease free carrier absorption and increase the transmission signal to achieve higher signal to noise ratio which could have been a major limiting factor for the lack observation of CR in the structures. We plan to continue our collaboration with the group of Prof. Furdyna at the University of Notre Dame on different aspects of this project.

Acknowledgements

We acknowledge the support from the NHMFL to perform the experiment and Dr Y. J. Wang for his great contributions during our experiment.

References