Resonant Second Harmonic Generation of Mid-infrared Radiation in InAs/AlSb Coupled Quantum Wells

Hunil Cha[1], Darius Morris[1], Junichiro Kono[1], Shige Sasa[2], and Masataka Inoue[2]
[1] Department of Electrical and Computer Engineering, Rice University, Houston, TX 77005, USA
[2] Osaka Institute of Technology, Osaka, Japan
email: criss5946@yahoo.com

We have studied the intersubband transitions (ISBT) in InAs/AlSb coupled quantum wells (CQW) in order to explore nonlinear optical frequency conversion schemes for producing widely tunable short-wavelength mid-infrared (mid-IR) radiation.

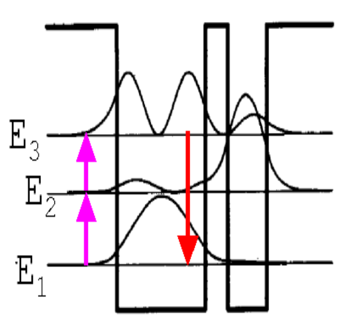
The fundamental resonant frequencies of many molecules are located in the mid-IR range. These frequencies make trace gas detection possible. For these sensory systems, adequate sources and detectors are needed. This project focuses on developing materials for appropriate mid-IR sources. Engineers have used bandgap engineering to produce CQW structures that have distinct ISBTs which can be used for frequency transformation therefore producing second harmonic generation (SHG) into the mid-IR range.

We have studied SHG in two distinct types of sample structures. The first structure couples quantum wells in such a way that it creates resonance transitions perfect for converting 6 μm light into 3 μm light with more powerful mid-IR laser sources [see Fig. 1(a)]. The second set was engineered to have larger ISBT energies, for the transformation of 3 μm light into 1.5 μm light, which is useful for telecommunication purposes.

InAs/AlSb quantum wells would be an ideal candidate for this investigation because of its large conduction band offset (~2.1 eV), which is useful for increased flexibility in tailoring quantum-confined states used to resonantly enhance SHG.

We have used Fourier-transform infrared (FTIR) spectroscopy to measure the ISBTs of these InAs/AlSb quantum well structures. Typical data is shown in Fig. 1(b).

A



B

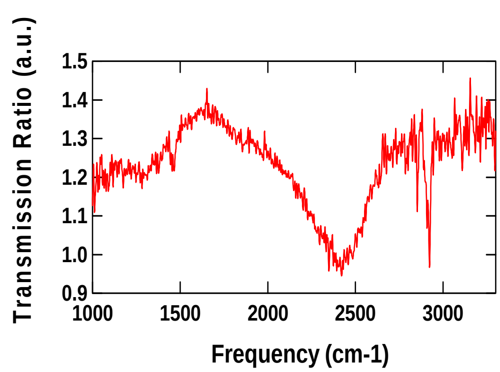


Fig. 1 **(A)** Two photon absorption process and emits one photon at twice the frequency. **(B)** Plot of transmission ratio versus the frequency, measured using FTIR. Used to measure ISBT of CQWs.