Low Cost Electroreflectance for High Band gap Semiconductors

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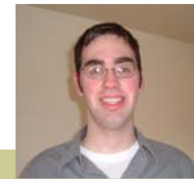
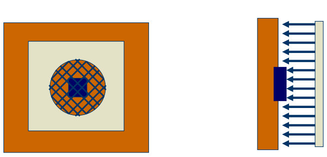


Overview of Modulation Spectroscopy

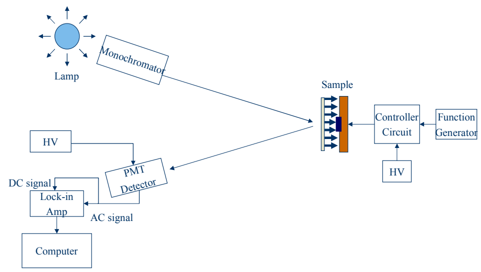
- The optical properties of the semiconductor are modulated through either external or internal modulation
- Spectra usually consist of derivative-like shapes which enhance weak features
- This derivative-like nature enables many aspects to be observed even at room temperature
- Data is usually normalized and graphed as $\Delta R/R$ vs. Energy (eV)
- A lineshape fit can be performed on this data to determine energies of interband transitions
- This type of spectroscopy can be applied to high band gap semiconductors that might be difficult to study with other methods

Design of Sample Holder

- A capacitor was designed consisting of a copper base plate and a wire mesh layer
- Sample is attached to the grounded copper plate and a square wave modified potential is applied to the mesh
- Capacitor creates a near uniform electric field but mesh is transparent for reflectance
- Some considerations on design
  - Capacitance of holder
  - Potential across the plates
  - Power consumption
  - Visibility through mesh

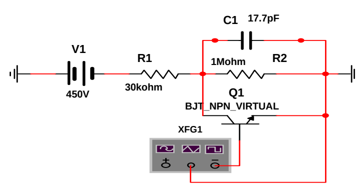


Setup



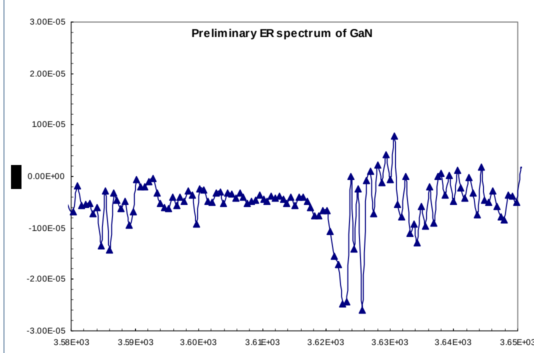
Control Circuit Schematic

- Circuit provides a high potential alternating current
- Requires only simple components, standard function generator, and a high voltage supply



Experiment Walkthrough

- Source lamp is run through a Monochromator reflects off the sample to provide a DC signal proportional to $I_o(\lambda)R(\lambda)$
- A high potential square wave is put across the two plates to generate an off-on modulation of the sample
- The sample's reflectance is modulated an amount ΔR
- The light reflected off the sample is focused into a photomultiplier tube (or photodiode to reduce noise)
- The AC signal (ΔR) is fed into the lock-in where a band-pass filter is synced to the modulation wave
- The DC signal (R) is fed into the lock in just to enable the signal to be run into the computer
- The lock-in is accessed through a LabVIEW program that collects wavelength, R, ΔR
- Data is lineshape fitted and various interband transitions can be determined from the lineshape



Preliminary Results

- Spectrum shows a possible transition at 3622 Å
- More tests needed to see if design works
- Spectrum overrun with electronic noise
- Perhaps with a stronger electric field and greater noise reduction clearer results can be obtained
- Low cost alternative to other forms of Electroreflectance that can expand to higher band gap semiconductors

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