**Introduction**

- The goal of the project was to build a micro-PL and Raman spectroscopy system.
- This system allows one to identify material characteristics, like semiconductor bandgap, molecule type or chemical bonding.
- Photoluminescence (PL):
  - When atoms interact, electrons form bands of energy levels with bandgaps.
  - Aiming photons of higher energy than bandgap at a material excites electrons to a higher band.
  - As electrons fall to a relaxed state, they lose energy in the form of emitted photons, or PL.
- Raman effect:
  - Phonons carry vibrational energy of a crystal structure.
  - Aiming high energy photons at a material excites the phonons.
  - Some of the photons lose energy and exhibit inelastic scattering (Raman effect).
- Micro-PL and micro-Raman spectroscopy deals with collecting PL and Raman spectroscopy from micron sized features.

**Methods**

- I designed and built the system keeping in mind the optical path and the mechanics of the parts:
  - A 658 nm (red) laser was aligned to enter the system and induce the PL and Raman effect on the sample.
  - A white light source was added to illuminate the sample to allow it to be imaged by the camera.
  - Using neutral density (ND) filters and mirrors, the laser and white light beams are reflected and transmitted to the sample and then to the spectrometer and camera.
  - 20X and 100X microscope objectives were added to focus the laser and white light onto a desired area of the sample.
  - Lenses focus the PL/Raman scattered photons and white light to a spectrometer and a camera.
  - A CMOS camera was installed to allow a zoomed-in view of the sample and the laser hitting the sample.
  - A spectrometer collects the PL and Raman scattered photons emitted from the sample.
  - Sensors on the spectrometer detect the intensity of incoming light at 2 nm wavelength intervals.
  - Intensity of incoming light (count of photons) vs. wavelength of light is plotted by a program.
  - An isolated increase in intensity on the graph after blocking the laser usually indicates the desired result (PL or Raman effect).

**Results**

- A graph of the PL from the same InP sample collected by the system using a 658 nm laser at 125 mA and 50 seconds of exposure. The bump around 920 nm is the observed PL.

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