Quantum Dots

Objectives

- Learn about basics of atomic spectroscopy, resolution, spectral line shapes, detector technology, calibration of the spectrometer etc.
- Learn how to fit peaks with standard peak functions such as Gaussian, Lorentzian and Voigt functions.
- Check the calibration of the spectrometer using known lines from atomic vapor emissions or lasers.
- Obtain the emission spectra of a variety of interesting sources using a computer-based spectrometer equipped with a charge coupled device detector and a fiber optic coupler. Compare with the quantum dot spectrum.
- Relate the peak emission of semiconductor quantum dots to their size.

Reading

- Study the Cenco quantum dot manual and the paper by Brus on semiconductor quantum dots.
- Read an introduction to semiconductor physics, including the concepts of valence band, conduction band, and band gap.
- Read the Ocean Optics manual for information about the spectrometer.
- Read about the atomic structure of hydrogen for the basics on emission lines from atoms.

Experimental Details

1. Learn how to use the Ocean Optics spectrometer. Understand the spectral range and resolution of the spectrometer, sensitivity of the detector and detector characteristics such as number of detector elements, physical dimensions, etc. Understand the various software settings such as integration time, etc. Understand how the spectrometer disperses light.
2. Use the Ocean Optics spectrometer to obtain the spectrum of a calibration source(s), and generate a calibration curve by fitting a quadratic (or cubic) curve to expected wavelength vs. pixel calibration data. (Read the manual.) Obtain the pixel value of the peaks by fitting the peaks of the spectrum. Hydrogen and Mercury lines, and HeNe laser are good calibration sources.
3. In software, use your calibration coefficients to transform spectra from intensity vs. pixel to intensity vs. wavelength.
4. Record the spectra of a variety of light sources such as: discharge tubes, LEDs, lasers, Hg lamp, halogen bulb, etc.
5. Record the spectra of the Cenco quantum dot suspensions.
6. Based on a model of the quantum dot energy levels, calculate the average radius of the dots in suspension from the peak emission wavelength.