Data analysis for the laboratory exercise on optics of quantum structures

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PLE spectroscopy on quantum wells

- Find the composition of the AlGaAs barrier, and the valence band and conduction band offsets using the PL spectrum ($\lambda_{exc} = 532$ nm), and appendix 3 in Davies' book[1]. Note that the band gaps in the appendix are for room temperature, where E_g^Γ for GaAs is 1.42 eV. Since you performed the experiments at a temperature of about 10 K it is more appropriate to use the band gap at 0 K, which is 1.52 eV for GaAs.

$$E_g^\Gamma = 1.52 + 1.247x \tag{1}$$

  The change in band gap with temperature is about the same over the entire composition range, so the interpolation formulas for the offsets can be used without any change. The two samples have different composition of the AlGaAs.

- Calculate the energies of all the bound states in the QWs ($L = 100$ Å and $L = 25$ Å). Appendix 3 in Davies' book contains the effective masses you need for calculating the energies of the bound states in the QW. Use m_Γ for the electrons. Calculate all the possible, that is allowed, interband transitions and compare this to the PL spectra and the PLE spectra.

- Indicate the transition corresponding to the light and the heavy hole states in the PLE spectrum. Which one is seen in the PL spectrum?

- Compare the relative intensities of the PL peak from the GaAs substrate and the QW with $\lambda_{exc} = 532$ nm and $\lambda_{exc} = 700$ nm.

- Can any transitions between excited states be seen in the PLE spectrum? If so: compare to your calculated transition energies. Can you also see this transition in the PL spectrum?

- Compare the two PLE spectra from the wider QW, where we detected the luminescence at different energies (corresponding to the QW and the GaAs substrate).

Raman spectroscopy on different semiconductors, including nano-wires

- Measure the Raman spectra of the AlGaAs sample provided by the supervisor. Use the phonon energies to determine the alloy composition of the AlGaAs barrier according to the article that was handed out. You will also get three unknown samples and you should measure their Raman spectra. Identify the samples from the spectra and explain why one sample has only one Raman peak whereas the other samples have two (strong) peaks.

References

[1] J. H. Davies *The Physics of Low-dimensional Semiconductors : An Introduction* Cambridge University Press, 1997 ISBN: 052148491X