Physics 8550 – Physics of Thin Films

Assignment #1: Semiconductors

(due to Feb 8, 2017)

1) a) What is the conductivity of intrinsic HgTe, Si, GaAs and ZnS. b) Why does the conductivity decrease with increasing bandgap? c) What mechanism do you have to change / control its conductivity?

2) Sketch the zincblende lattice for GaAs and identify the position of the atoms (If all atoms would be the same, what kind of lattice structure would you have?). Construct the Brillouin zone for this zincblende lattice.

3) What do you need to construct from the Brillouin zone the energy diagram?

4) Does a semiconductor need crystal symmetry? Explain and give a few examples for the choice of your answer.

5) Let's assume your semiconductor has two-dimensional (2D) crystal symmetry. a) Give two examples where you have only 2D symmetry. How do you construct you energy band diagram? How do the energy bands evolve in the third dimension?

6) Let's assume you have a group III-V compound semiconductor, say GaAs, and you want to grow on top an epitaxial 2 µm thick GaP layer. What criteria do you have consider to see whether it can be done? Can it be done?

7) Let's assume you have a group III-V compound semiconductor, say GaAs, and you want to grow on top an epitaxial - 2 µm thick ZnS layer. What criteria do you have consider to see whether it can be done? Can it be done?

8) Now lets assume you have a amorphous dielectric, say CaF, and you want to deposit SiO_2 onto it. How do the requirements in 7) change.

9) Name two crystalline semiconductor based device structures that only utilize the materials properties – no layers involved!

10) What material properties can be explored in a semiconductor device structures. Name at least 5 different ones and give examples.