Ae 244, Fall term 2007, HOMEWORK 4

Due on Monday December 3rd at 12pm (noon) in Linda Miranda's office Firestone 106.

Problem 1. General topics review *(50 points)*

1) What is a quantum dot? Why is it so much better than fluorescent dies for imaging? .How would you fabricate quantum dots on a flat substrate? List at least 5 viable techniques. (10pts)
2) Among the following, which are patentable and which are not? (10pts)
   (a) Improvements on someone else's invention such as improved core-shell QDs
   (b) Scientific principles such as electromagnetism
   (c) Naturally occurring nanomaterials such as nano-diamond particles
   (d) Combination of known materials/devices maintaining the same functionality (e.g., a telephone on a washing machine)
   (e) Carbon nanotubes discovered from a coal mine and purified to a high concentration
3) Describe the micelle and inverse micelle method and list at least one application for it (10pts)
4) What is the condition for wetting on CNT surface (such as to draw liquid into the CNT core)? Explain the basic principle in terms of Young's equation using the balance of surface tensions (γ_{SL}, γ_{SV}, γ_{LV}) and the wetting angle θ. Draw a schematic on this force balance. (10 pts)
5) You want to increase the mechanical properties of carbon nanotubes in compression. To delay buckling effects you opt to fill the hollow tubes with metals. List at least 2 techniques you would use to achieve such goal. (10 pts)

Problem 2. Thin Film Properties (30 points)

We wish to consider the epitaxial growth of a thin film of Ag onto (001) face of a perfect crystal of Cr. At what temperature might we expect an arbitrarily thick film of Ag to grow without forming misfit dislocation? (Hint: use the web-elements website to obtain the necessary information at: http://www.webelements.com/)

Problem 3. Semiconductor Fundamentals (20 points)

a) What factors affect the mobility of a carrier (2-3 sentences)?
b) Write a brief definition for the following:
   - conduction and valence bands
   - band gap
   - effective mass
   - intrinsic and extrinsic semiconductors

- dopant
- n-type and p-type materials
- majority and minority carriers
- Fermi distribution
- carrier mobility