MSE250 Final Exam Overview / Review

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Polymers

Complete the second discussion handout on structure-property relationships of polymers. As you are completing each graph, keep in mind the physical mechanisms (bonding, molecular structure/configuration) that are bringing about these relationships.Temperature and time dependence are key. What is distinctive about the graphs for each class of polymer? Compare your results to the posted solutions.

Rank the T_g of the following from low to high:PVC, HDPE, polycarbonate, PS, LDPE, PP, PET

solution: LDPE, HDPE, PP, PET, PVC, PS, polycarbonate

Composites

Draw a chart of the three main types of composites, and their subtypes. What are some common materials used in each type of composite?

What is the rule of mixtures? Why is it the upper bound (or "best" case) for a composite's properties?

What is the main purpose of using composites? What properties does each component confer on the whole material? Which composites result in (an)isotropic properties?

What are three reasons that effective fibers are thin and long?

Draw a schematic graph of how the specific strength of a composite would change as fiber length goes from discontinuous to continuous. With this in mind, can you recognize the form of the equations for specific strength and specific stiffness of fiber composites, without being told which equation applies to which case?

How do glass, graphite, and aramid fibers compare to each other in terms of specific strength, stiffness, and ductility? Suggest uses for composites containing each type of fiber.

Corrosion

Two metals (A and B) are connected by a wire, and each is placed in a solution containing its own ions. B is has a higher reactivity than A. Which will function as the anode/cathode? Can you write the simple reaction of what happens at each electrode?

What are the six common types of metal corrosion? Think of a system or environment where each type of corrosion could take place.

What is the dependence of corrosion rate on area of exposed surface?

Where does corrosion occur?? ☺

Electrical Properties

Can you explain why materials have an electronic band structure?

What is the significance of the Fermi-Dirac probability function, $f(E)$? What is the Fermi energy (Fermi level, E_F)? Draw $f(E)$ for T = 0K, and for T > 0K.

Write the atomic energy levels for Li, Ca, Al, N, and Si. Based on their valence orbital and what you know about the electronic properties of these materials (metal, insulator, semiconductor), draw a predicted band structure for each one.

What is a valence band? conduction band? band gap? Core band?

How does one use a material's electronic structure to determine whether a material is a conductor, semiconductor, or insulator?

All metals are good conductors, but not all good conductors are metals. Give an example of a conductive material that is non-metallic.

How does resistivity of metals, intrinsic semiconductors, and extrinsic semiconductors depend on temperature? Explain both the trends as well as the physical mechanisms that give rise to these property trends.

Draw the electronic bandstructure of intrinsic, n-type and p-type semiconductors. With these three images on the page and without looking at your notes, write down an expression for conductivity for each type of semiconductor (think Arrhenius equation!).

How would the conductivity of a metal alloy compare to that of a dispersion-strengthened composite of the same bulk metal? Why?

Given bulk semiconductor element(s) and an impurity, can you, using a periodic table, determine whether the resulting extrinsic semiconductor would be n-type or p-type?

General comments

This review guide does not cover equations or example problems in homework/class, but should prepare you well for understanding all the concepts needed in this course; consult your other study sources for the "complete picture".

The final exam will take place on Tuesday, December 20 from 10:30am – 12:30pm. It will be closed-book, closed-notes. You will be provided with necessary equations, but no labels indicating the meaning of those equations. A calculator and ruler are allowed.

The significance of study sources, with the most important being first, should be:

- Lecture notes
- Quiz 3/ homework
- Textbook (use wisely)
- Discussion handouts

Email me at tanaaron@umich.edu regarding questions or to set up a meeting time/place. Good luck!