

Exam 19.12.2017 - CHEM-E4215 - Functional Inorganic Materials

(as remembered, so there may be mistakes)

Three sections (*section 1: lectures 1-4, section 2: lectures 5-8, section 3: lectures 9-12*), four questions in each, must answer three questions from each section. Each question is worth 5 points (*15 points from exam needed to pass the course in autumn 2017, in addition to the lecture diary and exercises*).

1. Define the following terms
 - a) Total solar transmittance
 - b) Albedo
 - c) Skin depth
 - d) Solar heat gain
 - e) Solar irradiance
 - f) U-factor
 - g) Spectrally selective coatings
 - h) Low-e coatings
 - i) Luminosity function

 2.
 - a) What types of low-e coating and Solar Gain coating do you know? (Draw graphs and sketches)
 - b) How does a low-e glass work?
 - c) Metal and semiconductor resistivity vs. temperature? (Draw graphs and sketches)

 3.
 - a) How does a spectrally selective glass work?
 - b) Describe the different types of thin film growth (draw sketches).
 - c) How does SHGC change with respect to the amount of IR radiation?

 4.
 - a) Percolation threshold, what does it mean?
 - b) What is its impact on metal properties?
 - c) What has percolation to do with low-e coatings and metal particles etc.?
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5.
 - a) How does heat conduct in metals, insulators and superconductors?
 - b) Describe the thermal conduction behavior of an insulator in T range of 0 – 300 K.
 - c) How does the thermal conductivity of C, alpha-Si and alpha-Ge behave if they are compared to each other (which has highest therm. cond. and why)? Give one possible explanation to the trend you found.

 6.
 - a) In thermoelectrics, how do ZT, S, electrical and thermal conductivity depend on carrier concentration (doping level)? *See the graph in lectures.*
 - b) Mention three families of thermoelectric materials.

 7.
 - a) If a material has a change of spontaneous polarization, can it show the piezoelectric effect?
 - b) Mention one pyroelectric material and describe its atomic structure.
 - c) The difference between pyroelectric and thermoelectric energy harvesting?

 8.
 - a) The difference between soft and hard magnetic materials?
 - b) Why is it difficult to find new multiferroic materials?
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9. Which of these materials is a superconductor and why? If both are superconductors, tell which of them has higher T_c and why.
- Hg or Cu
 - $\text{La}_2\text{Cu}_{(?)}\text{O}_{(?)}$ or $\text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}$
 - $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_2\text{O}_{10}$ or $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$
 - The two YBaCuO structures with different oxygen content ($\text{O}_{6.1}$ and $\text{O}_{6.9}$)
 - $\text{HgBa}_2\text{Ca}_2\text{Cu}_3\text{O}_{9-\delta}$ or $\text{CoBa}_2\text{Ca}_2\text{Cu}...$
10. a) Where these materials could be applied in the future / where have they been applied to this day? Explain shortly what properties do they have related to this application.
- Li_xCoO_2
 - Na_xCoO_2
 - $\text{YBa}_2\text{Cu}_3\text{O}_7$
- b) Describe (roughly) in which temperature ranges these phenomena occur:
- superconductivity
 - (oxygen?) ion conductivity
 - proton conductivity
11. Describe which kind of properties are needed for
- SOFC cathode, anode and electrolyte
 - Li-ion battery cathode, anode and electrolyte
12. a) Why are oxygen non-stoichiometric compounds crucial for future research in terms of their properties?
- b) Why are inorganic-organic hybrid materials important for research in terms of their properties?

This is the last page! Congratulations!