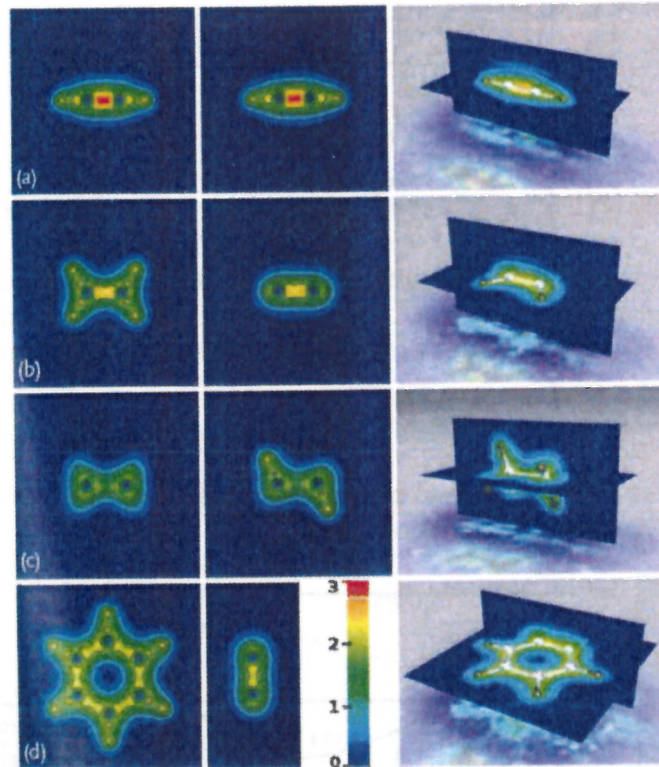


- 1.) a) What kind of secondary bonds you can find in materials? (1p)
 b) In figure below, charge density maps for different molecules are shown (on the scale given, red indicates the highest and blue lowest charge density). Identify the bonding type in each case and justify your answer. (3p)

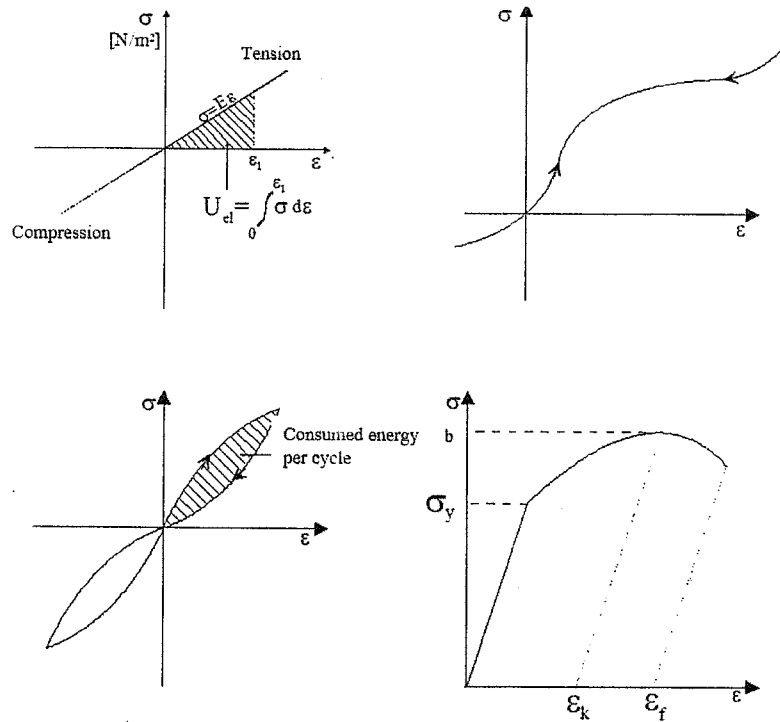


- c) The Wiedemann–Franz law states that the ratio of the thermal conductivity (κ) to the electrical conductivity (σ) of a metal is proportional to the temperature (T) as follows:

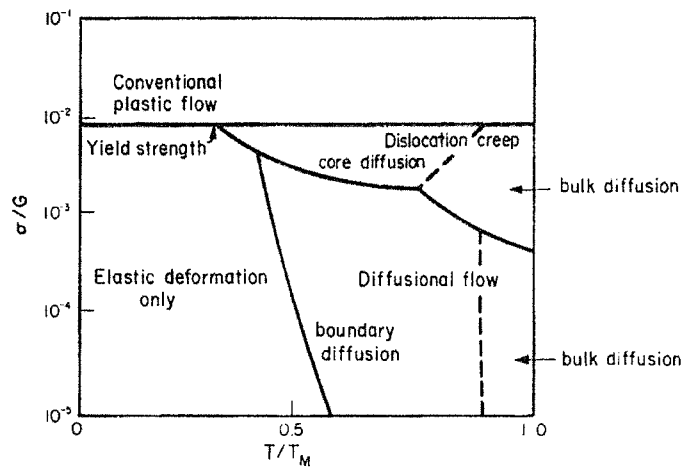
$$\frac{\lambda}{\sigma} = LT$$

where the proportionality constant L, is known as the Lorenz number. Explain the physical basis of this law. (1p)

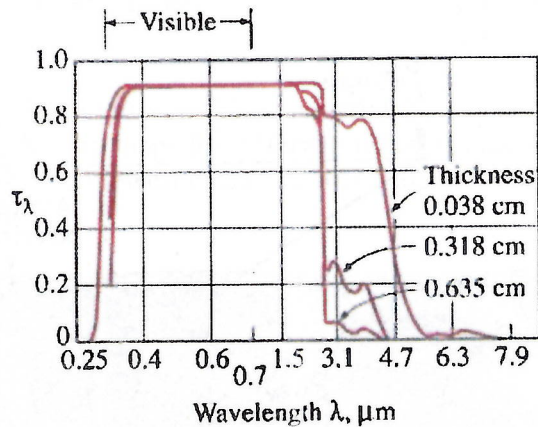
2. a) Explain why the fatigue fracture typically starts at the surface of the material? Give one example how to treat the surface of a typical metal to improve the fatigue endurance (1p)
 b) Explain the stress-strain behavior of the four different material types shown in the figure below and give an example material out of each group (2p)



c) Use the below deformation diagram to explain the mechanical behavior of the given material under different stress-temperature conditions (2p).

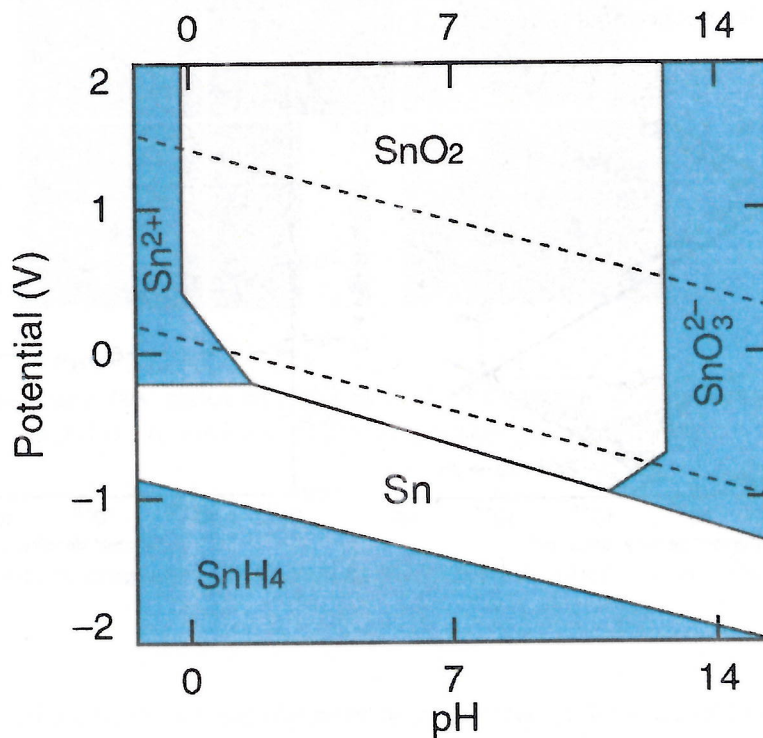


3. a) By which mechanisms heat is conducted in solids, liquids and in gases? (2p)
- b) Use the transmissivity figure for SiO₂ (main component in car windows) below to explain why car when left under direct sunlight acts as a heat trap and gets heated up from the interior? (2p)

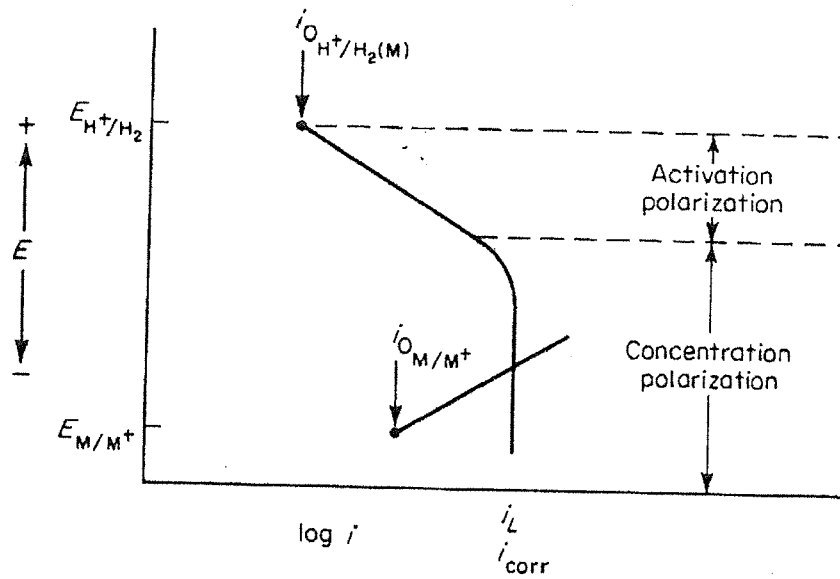


c) What is meant by the thermal contact resistance and what is its significance from the thermal management point of view? (1p)

4. a) Pourbaix diagram for Sn is shown below. Explain what is the meaning of the dashed lines in the figure and determine when Sn is in immune, active and in passive stage. In the pH region 4 to 8 what form of Sn you would use to catalyze oxygen evolution and why? (2p) (You can disregard SnH_4)



- b) Use the Evans diagram below to explain the phenomena taking place while the metal in question is dissolved. What happens to the dissolution rate of the metal in the same figure (and why) if you induce mixing to your system? (2p)



c) Explain by using the two diagrams below why Fe dissolves faster than Zn in dilute HCl even though it is thermodynamically more stable against corrosion (has less negative standard electrochemical potential). (1 p)

