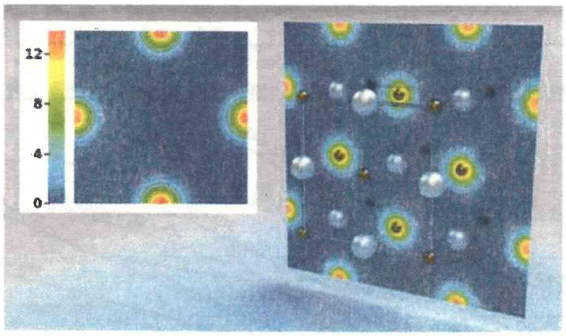
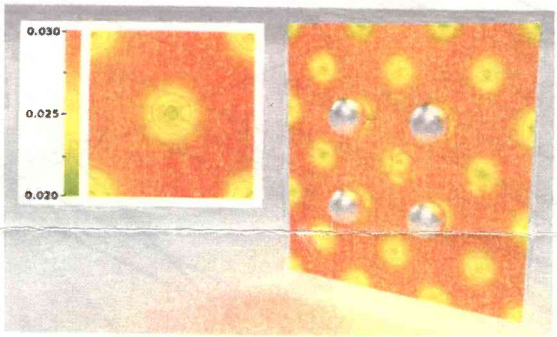
ELEC-D8710 Principles of materials science

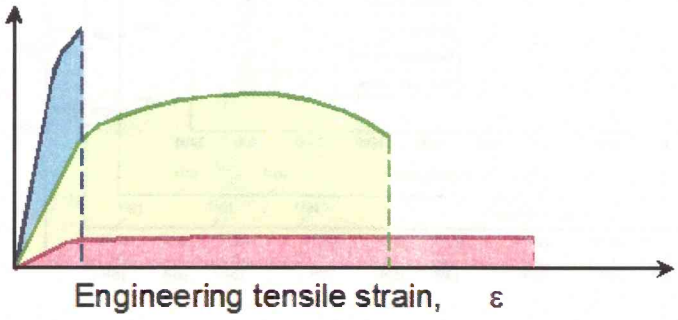
Extra exam 20.4.2018

1.) a) What kind of primary bonds you can find in materials? (1p)
b) In figure below, charge density maps for two different types of materials are shown. Identify the bonding type in each case and justify your answer. (2p)





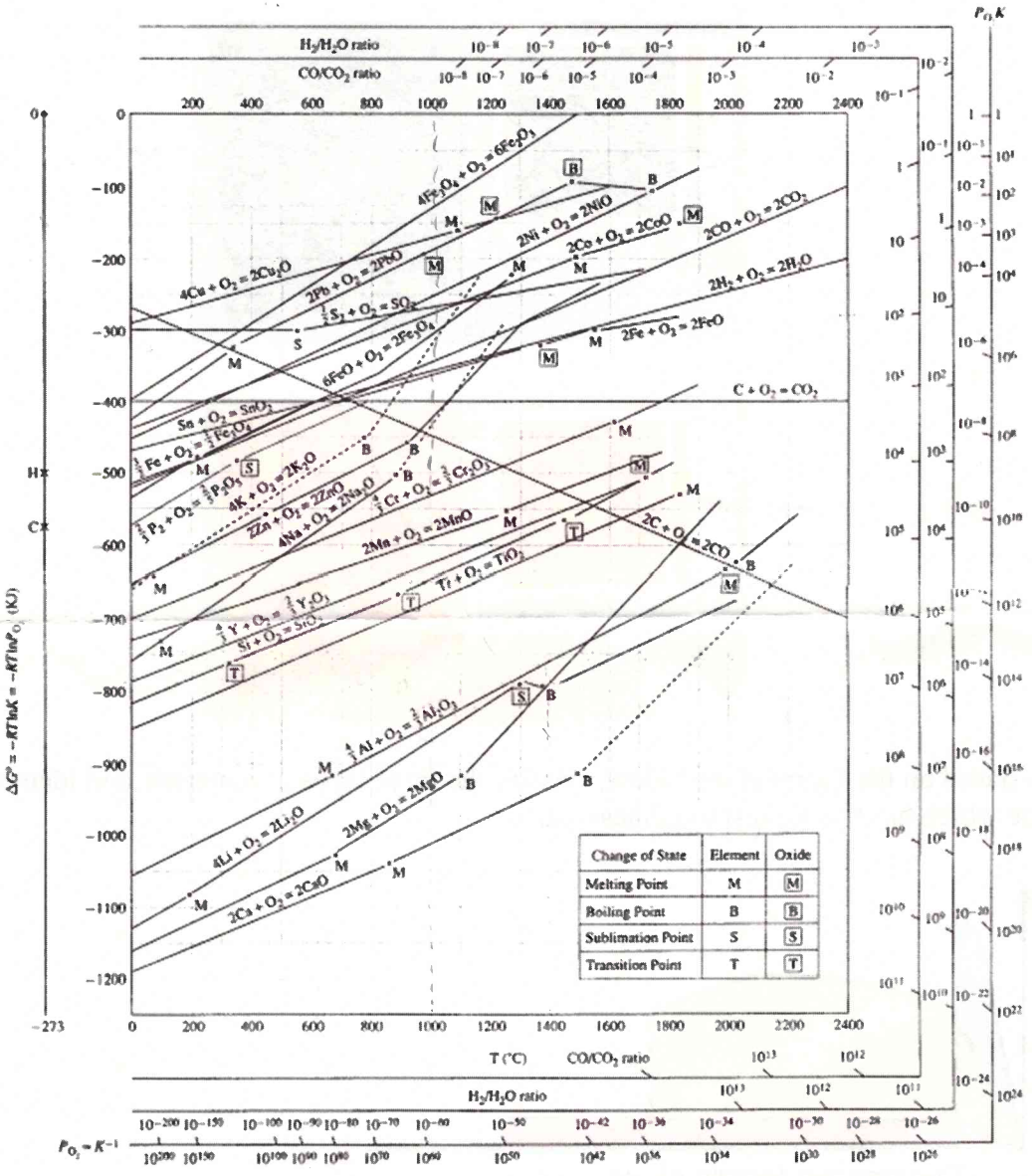
c) Based on the figure given below, classify the three types of materials and identify the one which has the highest toughness. (1p)



2. a) If you want to reduce Al_2O_3 at 1400 °C what is the oxygen partial pressure that you must go below? (2p)

b) You want to push the partial pressure of oxygen down to 10^{-30} (atm) at 1000 °C. What CO/CO_2 ratio you must use? (2p)

c) Mention at least two metals that can be used to reduce SiO_2 to Si at 1000 °C according to Ellingham diagram (1p)

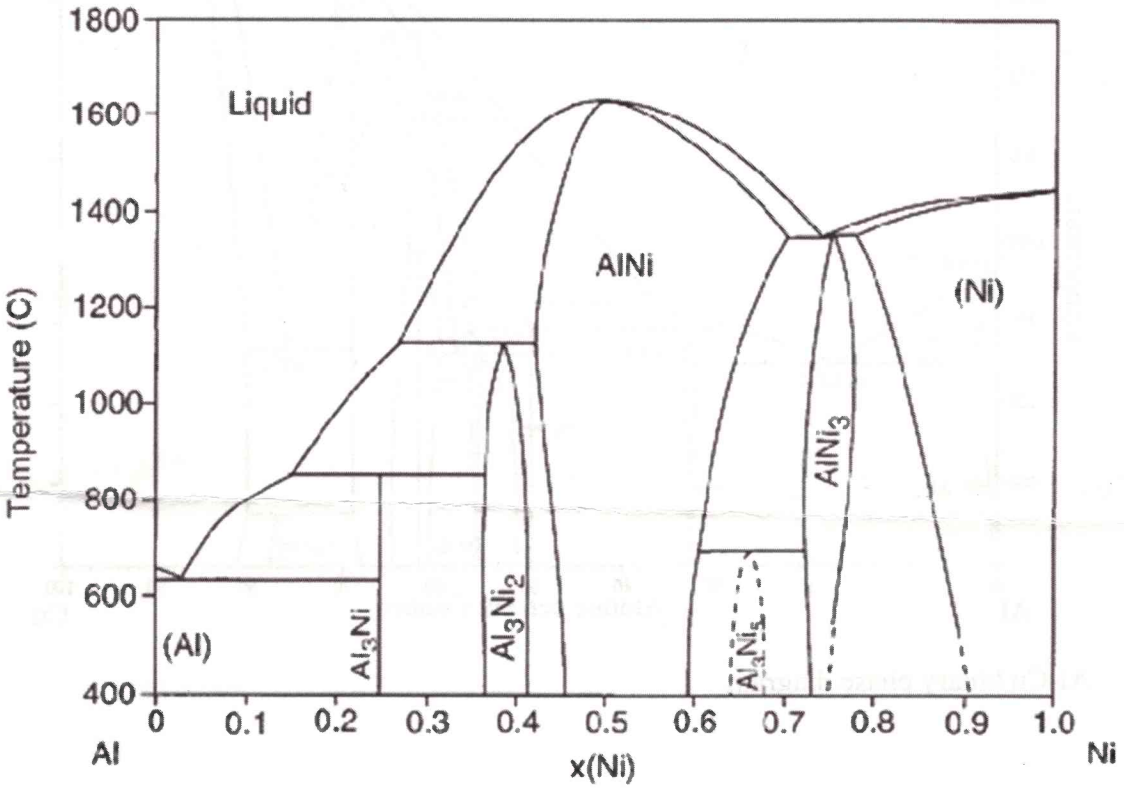


3. Based on the Al-Ni phase diagram, please answer following questions:

a) What can you say about the mutual interactions between Al and Ni atoms at solid state? (1p)

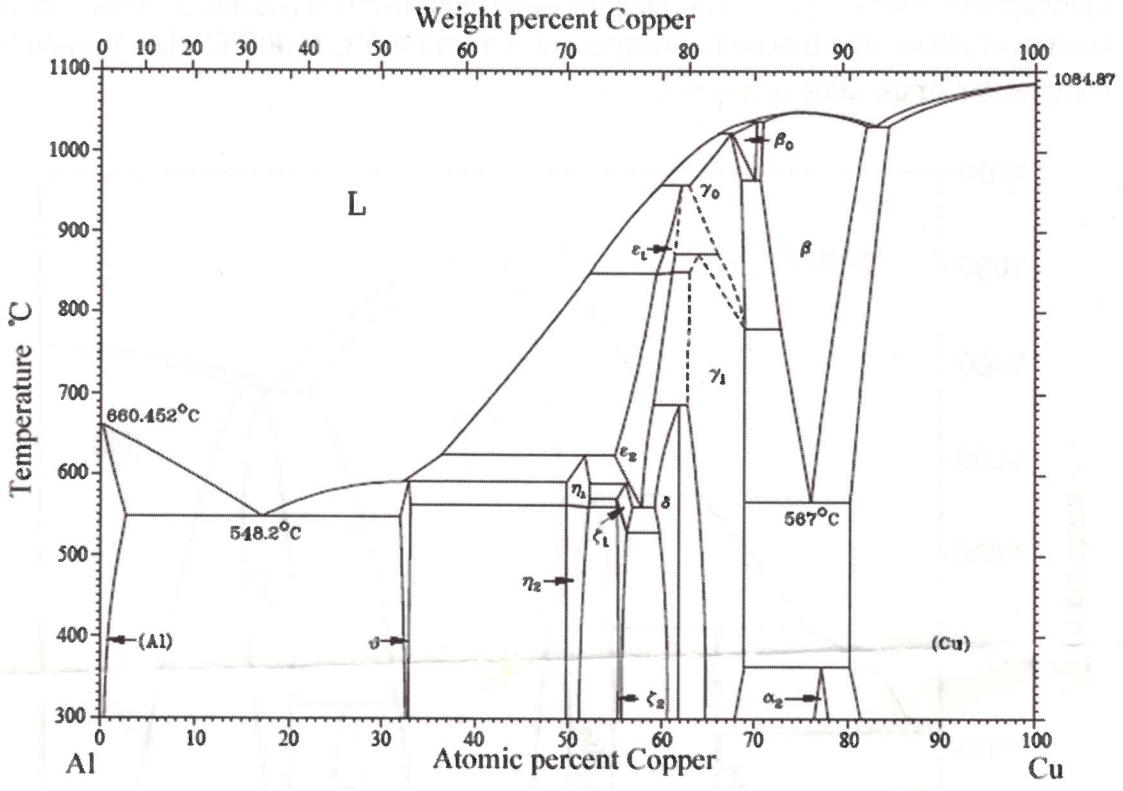
b) If the nominal composition of the AlNi alloy is $x_{Ni}=0.8$ and T=800°C, what phases are in equilibrium, what are their compositions and what is the relative amount of these phases? (2p)

c) Please explain the equilibrium ($D_{Liq}=D_{solid}=\infty$) solidification (i.e. the composition and amount of phases as a function of temperature) from 1600°C to 400°C when the nominal composition of the alloy is $x_{Al}=0.7$. (2p)



Al-Ni binary phase diagram

4. Thick aluminum (Al) and copper (Cu) metal plates are attached against each other (=semi-infinite diffusion couple) at the temperature of 500°C. Based on the phase diagram draw the structure of the diffusion couple and the composition profiles for both components, when sufficient amount of time has elapsed so that local equilibria is achieved in all interfaces. (NB. Mark clearly the compositions of the phases at all interfaces!). In addition, explain shortly what happens if the temperature is then decreased down to 300°C. (5p)



Al-Cu binary phase diagram