M. Sc. Physics, Semester-IV

Internal Assessment Examination March-2018

Paper: PHYS 531-Part-II - Physics at Nanoscale

Time: 1 Hour **Total Marks: 20**

Attempt all the questions as directed

Q1: Answer **all** the questions 1x5=5

i. Which pump(s) could provide a vacuum of 10^{-9} T?

(a) Tarbomolecular pump, **(b)** Diffusion pump

(c) Roughing pump, **(d)** Ion pump

ii. A metal thin film was planned to deposit over semiconducting material for electrical contacts. Which growth technique(s) would be suitable for this deposition?

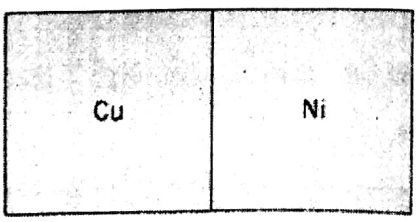
(a) Molecular beam epitaxy, **(b)** Sputtering

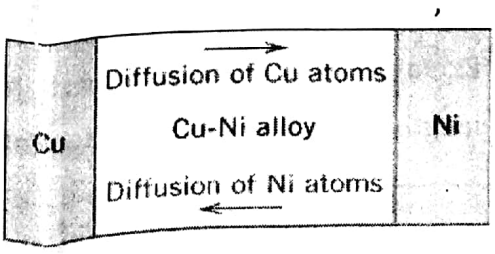
(c) Thermal deposition, **(d)** Metal organic chemical vapor deposition

iii. What is the isothermal compressibility $\kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_T$ for an ideal gas?

(a) -1/V, **(b)** 1/T, **(c)** 1/P, **(d)** nRT/P

iv. Cu/Ni alloy is formed by diffusion process as shown in the figure below. Draw the concentration of Cu and Ni w. r. t. the distance.





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v. Two atomic wires (W_1 and W_2) contain 5 and 10 atoms, respectively, have in the ballistic transport region. Their respective resistances (R_1 and R_2) will show,
(a) $R_1 = ½ R_2$, **(b)** $R_1 = 2 R_2$, **(c)** $R_1 = R_2 \neq 0$, **(d)** $R_1 = R_2 = 0$

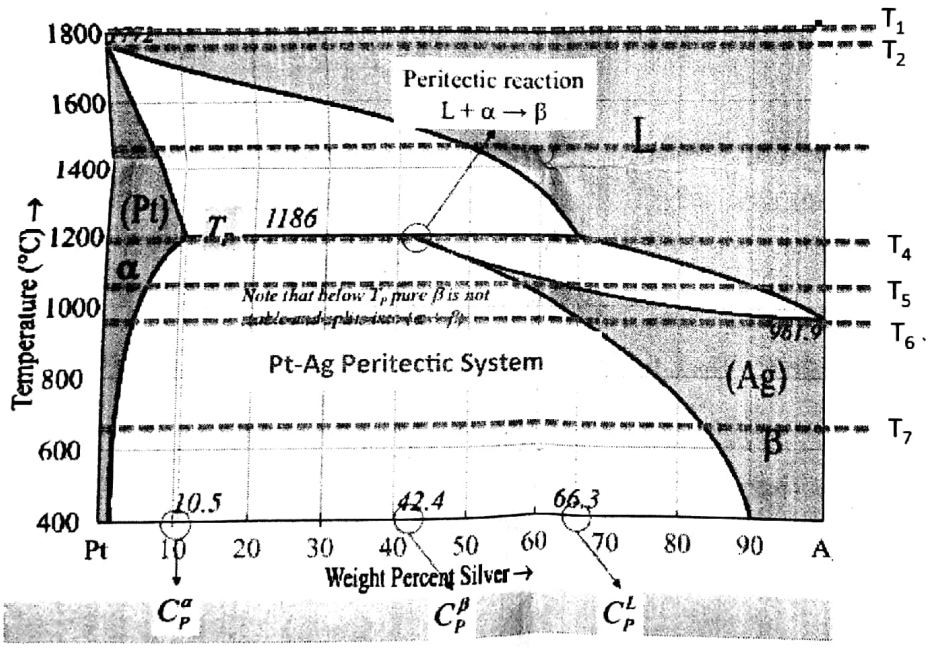
Q2: Answer **all** the questions 2x3=6

i. Find the difference between first two energy levels of a ultrathin film of thickness 10 nm.

ii. Draw the schematics for the Gibbs' free energy (G), Enthalphy (H), and specific heat at constant pressure (C_p) w. r. t. the temperature variation, for a second order phase transformation.

iii. The vapor pressure of diethyl ether is 100.0 torr at -11.5°C and 400.0 torr at 17.9°C. Calculate the enthalpy of vaporization of diethyl ether.

Q3: Answer **all** the questions 6+3=9



i. Draw the Gibbs' free energy diagrams at different temperatures $T_1 - T_6$ for the monotectic system showing the phase transition as in the diagram.

ii. Explain with schematics: The steps to grow GaN transistors with 2 μm channel length using various deposition techniques.

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