MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2015/2016

FIRST YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS

MAIN CAMPUS

SPH 823: THIN FILM TECHNOLOGY

Date: 9th May, 2016

Time: 2.00 - 5.00 pm

INSTRUCTIONS:

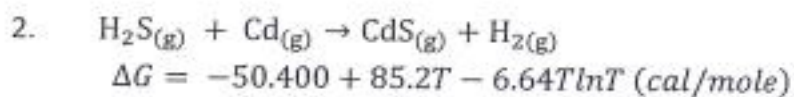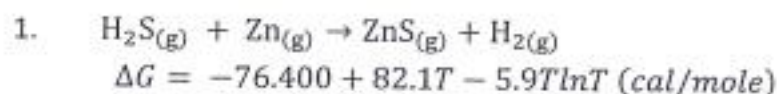- Answer ANY THREE questions.

SPH823: THIN FILM TECHNOLOGY

Answer any **three**

Q1. a) In metallic alloy such as Al-Cu estimate the approximate melt composition required to evaporate films containing 4 wt % copper from a single crucible heated to 1350 K. (8Mk:

b) Discuss potential reaction types in thermal evaporation of inorganic compounds, giving examples. (6Mks

c) Select the appropriate film deposition process (evaporation, sputtering, etc., sources and targets) with reasons, for the deposition of TiO_2–SiO_2 multilayers on artificial on artificial gems to enhance colour and reflectivity.
[Note: Molecular weight of copper and Aluminum are 63.7 and 27 respectively] (6Mks

Q2. a) Give reasons why multilayer optical filters have advantage over other types of filters. (5Mks)

b) Discuss the deposition processes and their effect on the refractive index n and the extinction coefficient k (5Mks)

c) After monitoring the thickness of a deposited Au film with a 6.0 (10Mk:

MHz quartz (AT cut) crystal monitor, a researcher decides to confirm his result employing interferometry. A frequency shift of 1022 Hz was recorded for the film measuring 1.00 cm^2 in the area. Interferometry with the Hg green line revealed a displacement of 1.75 fringes across the film step. Are these measurements consistent? If not, suggest plausible reasons why not?

Q3. a) Write a balanced chemical equation for the CVD reaction that produce Al$_2$O$_3$ films from the gas mixture consisting of AlCl$_3$+CO$_2$+H$_2$ (6Mks)

b) Assume you are involved in a project to deposit ZnS and CdS films for infrared optical coatings. Thermodynamic data reveal limiting potential (8Mks)

$$1. \quad H_2S_{(g)} + Zn_{(g)} \rightarrow ZnS_{(g)} + H_{2(g)}$$
$$\Delta G = -76.400 + 82.1T - 5.9T\ln T \ (cal/mole)$$

$$2. \quad H_2S_{(g)} + Cd_{(g)} \rightarrow CdS_{(g)} + H_{2(g)}$$
$$\Delta G = -50.400 + 85.2T - 6.64T\ln T \ (cal/mole)$$

i) are these reaction endothermic or exothermic?

ii) In practice reactions 1 and 2 are carried out at 680 °C and 600 °C respectively. From the vapour pressures of Zn and Cd at these temperatures, estimate the P_{H_2}/P_{H_2S} ratio for each reaction, assuming equilibrium conditions.

Q4. a) In many vacuum systems there is a gate valve consisting of a gasketed metal plate that acts to isolate the chamber above from the pumps below. (14Mk

i) A sample is introduced into the chamber at 760 torr while the

Isolated pumps are maintained at 10^{-6} torr. For a 15-cm-diameter opening, what force acts on the valve plate to seal it?

iii) The chamber is forepumped to a pressure of 10^{-6} torr. What force now acts on the valve plate?

b) Describe the turbo molecular pumps, what are their benefits in comparison to the diffusion pump? (6M

Q5. a) Distinguish between evaporation and sputtering. Discuss the differences in (i) production in vapour species, (ii) gas phase and (iii) the condensed film for the two cases. (6MI

b) An aluminum film was thermally deposited at a rate of $1 \mu m/min$ at 25 °C and oxygen content of the film was 10^{-3}. What was the partial pressure of oxygen in the system? (8MI

c) In a dc planar magnetron system operating 1000 V, the anode – cathode spacing is 10 cm. What magnetic field should be applied to trap electron within 1 cm of the target? (6M