Birla Institute of Technology and Science, Pilani, Rajasthan
First Semester 2022-2023
Comprehensive Examination (Closed Book)

Course Title: **Thin Film Technology** Course No. **PHY F379**
Time: 90 mins 20-12-2022 Total marks: **55**

- Each symbol has its usual meaning
- Answer to the point

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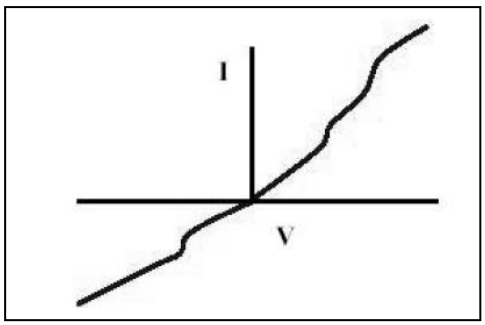
1. **Answer any 7 questions out of these 8 questions. Each question carries 4 marks**. **[28]**

i) Estimate the value of Reflectance when an unpolarized EM wave is normally incident from a medium of refractive index 1.3 to 1.6.
ii)What is the principle behind Xray reflectivity measurement? Name any three parameters of a thin film which can be estimated using the Xray reflectivity spectra.
iii) Name any two forms of Photoluminescence and draw energy level schematic diagrams to indicate those processes and also indicate the time scales for those processes.
iv) Define Magnetostriction and Magnetoelastic effect.
v) Write down the equation which relates the ratio of complex reflection coefficients with the physical parameters involved in ellipsometry measurement. Explain each term of the equation.
vi) What is molecular beam epitaxy? When this process will be preferred over other processes of thin film deposition?
vii) When will the hot wall CVD reactor preferred over cold wall CVD reactor? Explain the advantage and disadvantages involved in both the processes.
viii) Write four significant differences between Secondary electrons and back scattered electrons in context of SEM.

2. With the help a proper schematic diagram indicate the sequence of gas transport and reaction processes of a CVD process. **[6M]**

3. With the help a proper schematic, explain ATR FTIR spectroscopy. Name any two most common crystals used for that technique. **[6M]**

4. How will you determine the density of states from the given I-V curve of scanning tunneling spectroscopy? (Hint: Sketch the relevant derivative corresponding to this curve and explain.) **[5M]**



_____All The Best_____

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A

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QUIZ

Answer all the 5 questions of this part. Circle the correct option from the options given below each question. Each question carries 2 marks. **[10]**

1. In XPS, the peak intensities give information about _____the of a material. The greater the_____ the greater the attraction of that to_____ the _____.
   a. percent composition, binding energy, electron, photon
   b. binding energy, lattice spacing, electron, photon
   c. percent composition, binding energy, electron, nucleus
   d. density, binding energy, photon, nucleus

2. Cadmium Telluride, a_____, and is a good candidate for Thin-film_____material, because of its large_____, its ability to be doped, and its near optimum _____ for solar energy conversion.
   a. semimetal, photoresistor, optical absorption coefficient, band gap
   b. semiconductor, photo voltaic, optical absorption coefficient, band gap
   c. semiconductor, photo voltaic, electron absorption coefficient, fermi level
   d. dielectric, photo inhibitor, optical absorption coefficient, band gap

3. Reflection of a _____ from the surface of a material with an _____ results in a change of the polarization state and/or the _____that is dependent on the----------. This phenomenon is known as the magneto-optic Kerr effect.
   a. polarized optical wave, internal magnetization, reflectivity, intensity of Electromagnetic wave
   b. polarized optical wave, internal magnetization, transmittivity, magnetic field
   c. unpolarized EM wave, spontaneous polarization, absorptivity, magnetic field
   d. polarized optical wave, internal magnetization, reflectivity, magnetic field

4. Isothermal _____ elastic modulus of a Langmuir monolayer is _____ to the compressibility of the monolayer and indicates the strength of _____ .
   a. in-plane, directly proportional, phase transition
   b. out - of -plane, directly proportional, phase transition
   c. in-plane, inversely proportional, phase transition
   d. in-plane, quadratically proportional, transfer ratio

5. In Nyquist plot _____ vs _____ is plotted, whereas in a Cole-Cole plot _____ vs _____ is plotted.
   a. imaginary part of impedance, real part of impedance, imaginary part of dielectric permittivity, real part of dielectric permittivity
   b. imaginary part of dielectric permittivity, real part of dielectric permittivity, imaginary part of impedance, real part of impedance
   c. imaginary part of impedance, frequency, imaginary part of dielectric permittivity, frequency
   d. real part of impedance, frequency, real part of dielectric permittivity, frequency

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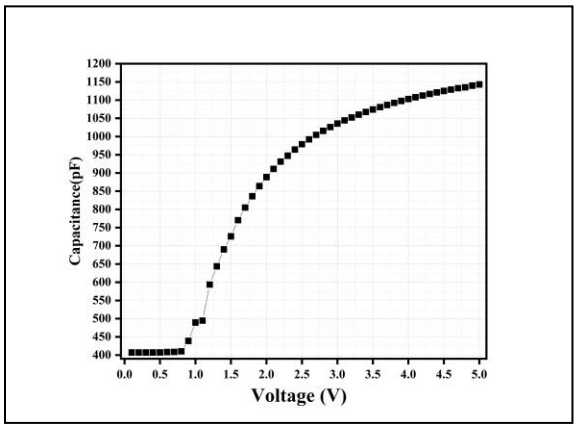
1. Using the given plot of capacitance versus voltage estimate the following parameters of a nematic Liquid crystal. The empty capacitance of the LC cell and area of the cell are 78.8 pF and 0.72 cm^2 respectively. A laser of 630 nm wavelength is used to carry out the transmittance measurements. The intensity observed when the planar aligned cell between crossed polarizers at that temperature is 0.6 I_0. **[4+6]**



a) dielectric anisotropy (**$\Delta\varepsilon$**)
b) birefringence (**$\Delta\mu$**)

2. A Kretschmann configuration of a SPR setup was used to obtain the SPR condition for a metal and dielectric material pair whose relative dielectric permittivity were 7.2 and 1.7 respectively for a wavelength of source of 600 nm. (i)The light is incident onto this metal dielectric pair through a glass prism at an angle of 40° to achieve SPR condition. Find out the refractive index of the prism. (ii) In the second measurement, due to analyte adsorption the dielectric constant of the dielectric material is changed to 1.6, using the same prism, what should be the angle of incidence to achieve SPR condition. **[6+6]**

3. A capacitor of 1nF is connected in series with a resistor of 5KΩ, calculate the impedance and resonance frequency of this circuit and hence plot the Bode plot and Nyquist plot.**[3+3+3+3]**

4. A thin film solar cell with a fill factor of 0.8 generates a photo-current density of 40 mA/cm^2. Given the area of the solar cell is 5 cm^2.The efficiency of the solar cell is 40% for an input power of 1 kW. Calculate the relevant parameters required for plotting the current vs voltage of a solar cell and plot it and show their values in the plot. **[8]**

5. Calculate the magnetoresistance using this data given the probe current is 4mA and resistance in absence of magnetic field is 43.92 Ω. (only for the 5 underlined field values). Plot log of magnetoresistance vs log of magnetic field.
[4+4]

Mag. Field H (KG)	Voltage V_m (mV)
0.087	175.7
0.310	175.7
0.537	175.8
0.793	175.9
1.035	176.1
1.290	176.3
1.544	176.6
2.050	177.2
2.550	178.0
3.050	178.9
3.530	179.9
4.000	180.9

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B

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