



RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B. Sc. (Four year) Degree in Applied Sciences
Fourth Year - Semester I Examination – June / July 2018

PHY 4308 – CHARACTERIZATION TECHNIQUES

Answer four questions only

Time: 3 hours

1.

- a) Show that the real and imaginary parts of the capacitance of the capacitor are given by equation (1) and (2) respectively (symbols have their usual meaning).

$$C' = \frac{-Z''}{\omega(Z'^2 + Z''^2)} \quad (1)$$

$$C'' = \frac{Z'}{\omega(Z'^2 + Z''^2)} \quad (2)$$

Hence, show that real and imaginary parts of the dielectric constant are given by equation (3) and (4) respectively;

$$\epsilon'_r = \frac{-Z''}{\omega C_o(Z'^2 + Z''^2)} \quad (3)$$

$$\epsilon''_r = \frac{Z'}{\omega C_o(Z'^2 + Z''^2)} \quad (4) \quad (60 \text{ marks})$$

- b) Consider a parallel-plate capacitor having an area of $6.45 \times 10^{-4} \text{ m}^2$ and a plate separation of $2 \times 10^{-3} \text{ m}$ across which a potential of 10 V is applied. The space between the plates was filled with a material having a dielectric constant of 6.0. Electric permittivity of a vacuum is $\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$, calculate,

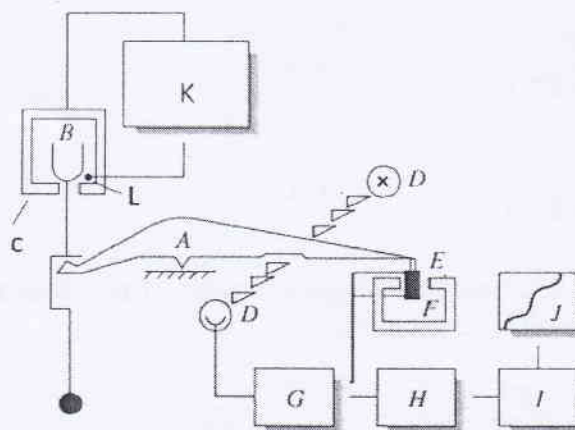
- I. The capacitance.
- II. The magnitude of the charge stored on each plate.
- III. The dielectric displacement D .
- IV. The polarization. (40 marks)

2.

a) Briefly describe the followings.

- I. What is reproducibility in Thermal Gravimetric Analysis (TGA) and why is it important.
- II. How can the TGA be used to ensure product safety. (26 marks)

b) This is a schematic diagram of a Thermo-balance. Name the components A-M.



(24 marks)

- c) Explain how to calibrate a Thermo Gravimetric Analyzer? (20 marks)
- d) Using appropriate examples explain how TGA can be used as a quality assurance and quality control tool to ensure product specifications. (20 marks)
- e) Sketch a thermal curve for Calcium Oxalate Monohydrate. (10 marks)

3.

a) Briefly explain the followings.

I. Differential Thermogram.

II. Advantages and disadvantages of Differential Scanning Calorimetry (DSC).

(20 marks)

b) Explain how you can determine percent crystallinity from DSC. (20 marks)

c) List 5 properties which can be measured with DSC. (10 marks)

d) What is the best way to carry out DSC for bacterial membranes? (30 marks)

e) What is Oxidation Induction Time (OIT) in DSC? Explain with an appropriate example and a thermogram. (20 marks)

4.

a) Describe the *Rayleigh Criterion of Resolution*. (10 marks)

b) What are the two image contrast mechanisms used in Scanning Electron Microscopy (SEM)? (20 marks)

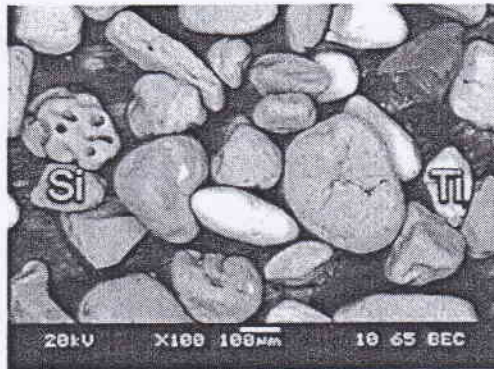
c) Explain why the SEM can provide the user with exceedingly detailed topographical and compositional information. (30 marks)

d) "*Metallic coating is required for non-conducting samples of SEM*"
Substantiate the above statement. (20 marks)

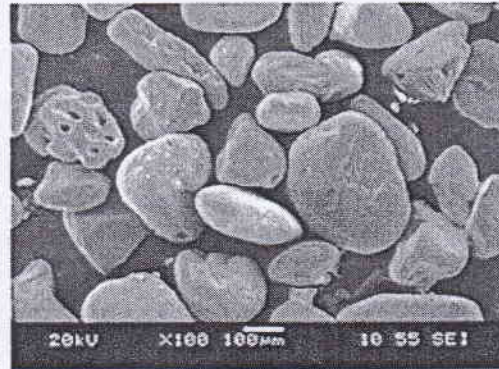
e) What is Environmental Scanning Electron Microscopy (ESEM) and what is it used for? (20 marks)

5.

- a) Comment on the following Scanning Electron Microscopy (SEM) images of a sand sample made up of a Titanium (Ti) mineral and a silicon (Si) mineral. (50 marks)



Backscattered electron image (BSE)



Secondary electron image (SE)

- b) Distinguish between Energy Dispersive X – Ray Microanalysis and Wavelength Dispersive X – Ray Microanalysis used in conjunction with SEM. (30 marks)
- c) Explain why the X-Ray microanalysis cannot be used in the identification of isotopes of a given sample. (20 marks)

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