Question Paper

MANIPAL ACADEMY OF HIGHER EDUCATION

SEVENTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2022

Biomaterial-characterization techniques [BME 4052]

Marks: 50   **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1)
A) A metal has two phases α and β. The α shows a face-centered crystal lattice (FCC) while the β phase shows Body centered crystal lattice (BCC). Predict the properties of the two phases of the metal. (4)

B) Biomaterials generally have to withstand abrasion when implanted in the body. Propose a method to understand the resistance to surface abrasion. (3)

C) Ron developed a core-shell nanostructure with zinc oxide forming the core and gold forming the shell. Ron wants to characterize the formation of the core-shell structure. Choose an appropriate imaging technique to characterize the formation of the core-shell structure and write in detail about the principle, components, contrast mechanism, and working of your chosen method with suitable illustrations. (3)

2)
A) Preethi is working on modifying the surface of nanomaterials with a functional group to improve the solubility of the nanomaterials. She has coated the nanomaterials with polymer- PEG. Propose a technique that Preethi can use to confirm the coating of PEG on the nanomaterials. Explain in detail the parts and the functioning of your proposed instrument with suitable illustrations. (4)

B) Anwar characterized a nanomaterial using XRD. The following table shows the data acquired by Anwar. From the data calculate the average size of the nanoparticle. X-ray wavelength =1.54060 Å and dimensionless shape factor K=0.94 (2)

| 2θ	FWHM
32.08	0.230
37.93	0.240
43.80	0.240

C) Ruchi has developed a conductive nanocomposite for neural tissue engineering applications. Ruchi wants to study the electronic properties and surface features of the nanocomposite material she has developed. Suggest a characterization technique that Ruchi can utilize for her study. Discuss the various elements and the working of the suggested instrument with suitable diagrams (4)

3)
A) Compare the difference between UV-vis spectroscopy and fluorescence spectroscopy. Explain the application of both techniques with a suitable example. (4)

B) Ron modified a surface with a polymer coating. Ron characterized the surface using contact angle measurement and the results are shown in the below figure. Analyze and interpret the image given below. (2)
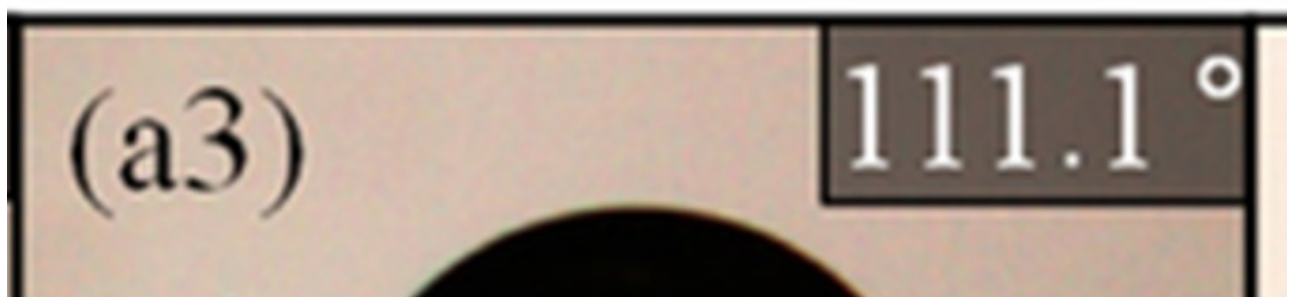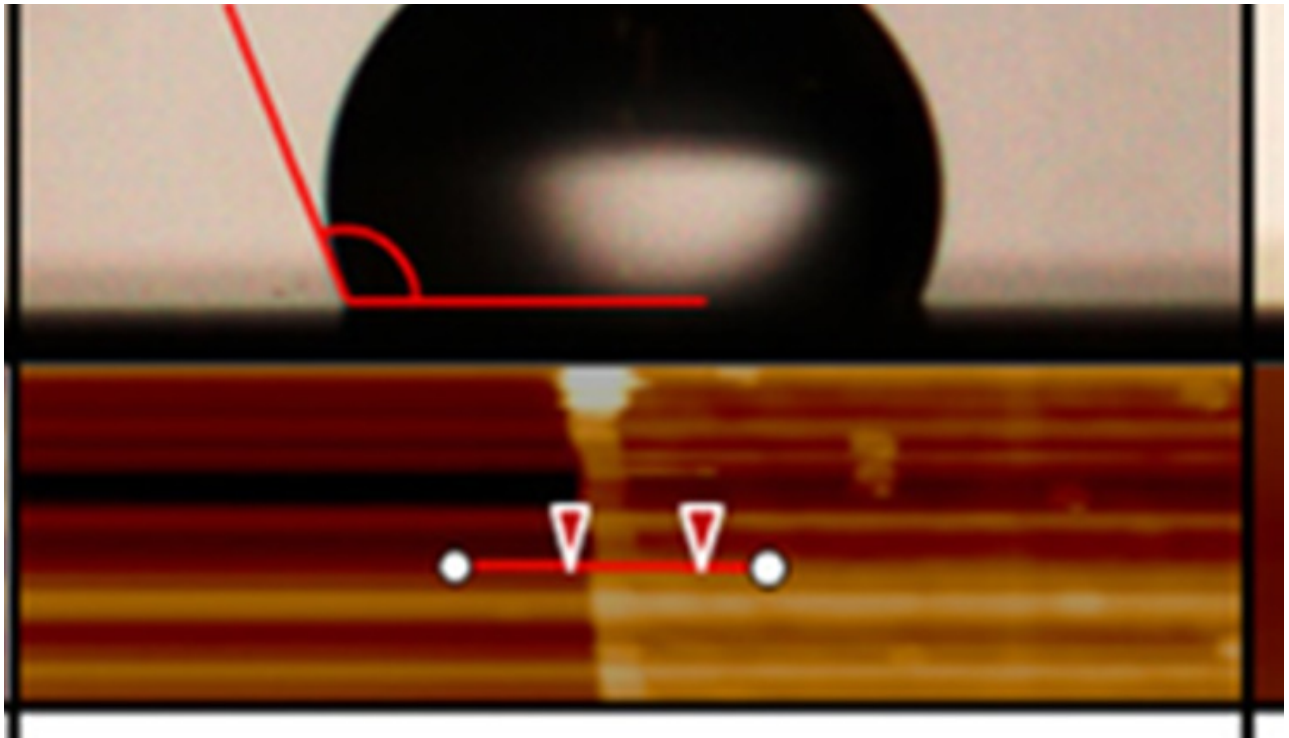
| C) | A group of scientists is working on developing a coating for a biomaterial. While coating the surface, the group noticed the evolution of a volatile byproduct. Propose a characterization technique that the scientist can adopt to determine the byproduct formed. Write about the working and various components of the proposed instrument used for characterization with suitable illustrations. | (4) |

| 4) | | Roy synthesized a spherical nanoparticle by the precipitation method. Roy wants to determine the hydrodynamic radius and surface charge of the nanoparticle. Choose an appropriate characterization method to determine hydrodynamic radius and surface charge. Explain the principle, components, and the working of the chosen method with suitable illustrations | (3) |
| | A) | | |

| | B) | A company wants to develop a novel filament for FDM 3-D printers. For this, the company was to determine the glass transition temperature of the new blended filament. Suggest a characterization technique that the company can utilize to determine the glass transition temperature. Explain the various parts and components of the instrument used to determine the glass transition temperature. | (4) |

| | C) | Discuss the role of thermogravimetric analysis in identifying the amount of filler in a nanocomposite material. | (3) |

5)		Compare the various mass analyzer used in mass spectroscopy with suitable illustrations	(4)
	A)		
	B)	Discuss depth profiling with Secondary ion mass spectroscopy	(2)
	C)	Distinguish between x-ray photoelectron spectroscopy and Auger electron spectroscopy	(4)

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