Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	MATERIAL ANALYSIS AND CHARACTERISATION
COURSE CODE	:	BWC 40303
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Briefly define the terms below:
(i) Spectroscopy,
(ii) Microscopy.

(4 marks)

(b) Current technologies offer various scientific instrumentations to determine specific property of materials. Suggest at least **ONE (1)** instrument and its abbreviation (if any) that is capable to measure,
(i) chemical elements of unknown powder;
(ii) mass loss of volatile materials originated in soil;
(iii) particle size of nano material;
(iv) crystal phase of polycrystalline materials;
(v) surface morphology of bulk metallic glass;
(vi) oxidation state of iron oxide.

(6 marks)

(c) Tabulate the advantages and disadvantages of inductively coupled plasma-atomic emission spectroscopy (ICP-AES) compared to X-ray fluorescence spectroscopy (XRF).

(4 marks)

(d) Construct a complete schematic diagram that shows the working principle of Fourier transform infrared spectroscopy (FTIR). All parts in the schematic diagram must be labelled properly.

(6 marks)

Q2 (a) Describe the main purpose of using differential thermal analysis (DTA) and thermogravimetric analysis (TGA). Point out the major difference of these instruments.

(4 marks)

(b) Discuss why the atmospheric control is a more critical factor in TGA than in DTA analysis. Give **TWO (2)** examples of gas that frequently used for determining the thermal properties of materials.

(4 marks)

(c) Identify the factors and limitations of using mullite crucible in DTA experiments.

(4 marks)

(d) Draw and differentiate a typical TGA and DTA curves (thermograms) of glass-ceramic material. In your DTA curve, illustrate the position of glass transition temperature, T_g and crystallisation temperature, T_c.

(8 marks)

Q3 (a) Distinguish the bulk and powder densities of ceramic material. Determine the perfect instrument to measure bulk and powder densities of this ceramic.

(4 marks)

(b) Based on **Q3(a)**, discuss the working principle of each suggested instrument, which involes the sample preparation, theory, schematic diagram of experimental setup and data analysis that lead to the determination of bulk and powder densities of ceramic.

(12 marks)

(c) Rahem measured the powder and bulk densities of his sample and find out the value are 3.21 g cm^{-3} and 2890 kg m^{-3}, respectively. Based on your knowledge, help Rahem determine the percentage of porosity of his sample.

(4 marks)

Q4 (a) The X-ray diffraction (XRD) is a very useful tool for characterising the structural properties of glass materials. Clarify why most of the scientists prefer to analyse the powder sample rather than the bulk sample of glasses.

(4 marks)

(b) Sketch and compare the diffraction patterns of glass and ceramic materials.

(8 marks)

(c) Briefly summarise the working principle of XRD. Your answer must explain the generation of source, interaction of source with sample and the detection of signal.

(8 marks)

Q5 (a) List **TWO (2)** types of electron microscope that are widely used in materials science research.

(2 marks)

(b) Identify the area of the following statements by considering **Figure Q5(b)**: [Note: Point the areas/regions in **Figure Q5(b)** and submit **Page 5** together with your answer's booklet.]

(i) Isolated porosity,

(1 mark)

(ii) Interconnected porosity,

(1 mark)

(iii) **TWO (2)** different crystal regions.

(2 marks)

(c) Outline the information that can be characterised from secondary electron and backscattered electron signals.

(4 marks)

(d) The interaction of electron with solid sample is usually explained by using the interaction volume. Draw the interaction volume and explain the signals that are potentially emitted from the interaction between electron beam and solid sample.

(10 marks)

- END OF QUESTIONS -

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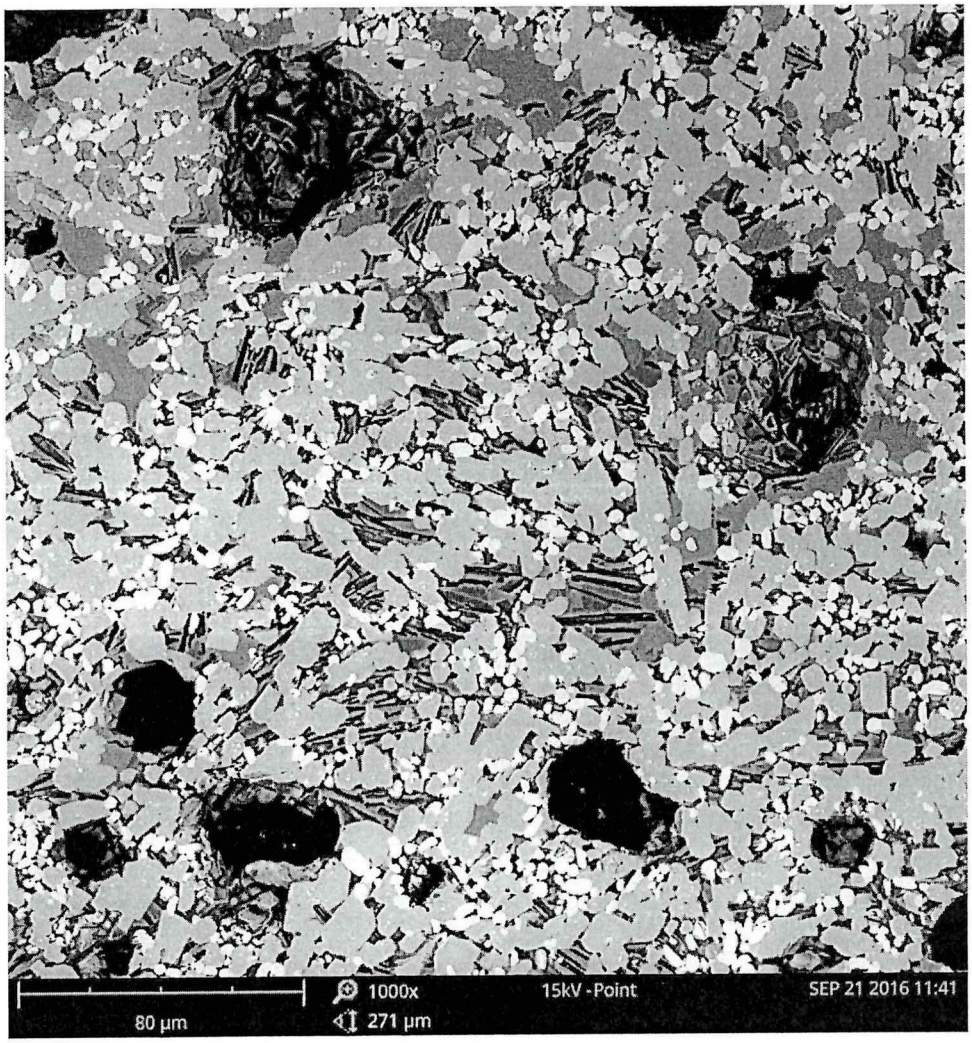

Figure Q5(b)