UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	MATERIAL CHARACTERIZATION
COURSE CODE	:	BED 41303
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS ALL THE QUESTIONS. OPEN BOOK EXAMINATION.

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Raman spectroscopy is a non-destructive chemical analysis technique which can detect both organic and inorganic species.

(i) Interpret *Raman Spectroscopy*.

(2 marks)

(ii) As a research student, analyze and explain the results that could be obtained from Raman measurement. Support your answer with the aid of diagram.

(8 marks)

(b) You received a Silicon dioxide on silicon wafer substrate (SiO_2/Si) sample from your supervisor. You need to observe the defects on the sample and measure the sample thickness using simple, non-vacuum, non-destructive, and optical characterization technique.

(i) Propose both techniques.

(4 marks)

(ii) Choose **ONE (1)** of the technique and explain step-by-step of your experiment flow.

(6 marks)

(c) Identify which concept of optical characterization technique used in part **Q1(b)**. Explain **THREE (3)** main measurement categories for the optical characterization technique stated in your answer.

(5 marks)

Q2 (a) As a research student, you need to investigate the morphological properties of Cuprous oxide (Cu_2O) thin film. The objective is to analyze the homogeneity of the surface.

(i) Select the most suitable apparatus for the measurement and explain how the image can be produced.

(6 marks)

(ii) Based on your answer in **Q2(a)(i)**, sketch and label clearly your prediction result.

(3 marks)

(iii) Analyze the strength of using proposed method in **Q2(a)(i)** over the optical microscope.

(3 marks)

(b) You received a task from your supervisor to analyze the most suitable technique to investigate the cross-sectional of very thin sample (less than 50 nm).

(i) Propose the appropriate technique.

(2 marks)

(ii) Analyze **THREE (3)** major differences with the apparatus in **Q2(a)(i)**.
(6 marks)

(c) (i) Explain the function of X-Rays Fluorescence (XRF) technique.
(2 marks)

(ii) Examine **ONE (1)** situation in which constituent of mixed conductor can be determined using XRF technique.
(3 marks)

Q3 (a) (i) Define *Failure Analysis*.
(2 marks)

(ii) Explain **TWO (2)** reasons and **TWO (2)** advantages to perform the Failure Analysis. Summarize in table.
(4 marks)

(b) Oxide breakdown on Metal-oxide semiconductor (MOS) device can be categorized into **THREE (3)** modes or regions.

(i) Explain the oxide breakdown effect if mode A occurred on the sample.
(4 marks)

(ii) Identify **TWO (2)** types of defect under mode A. Sketch and label clearly.
(4 marks)

(iii) Propose and explain **TWO (2)** procedures to characterize the lifetime and integrity of gate oxides.
(6 marks)

(c) The operating lifetimes of production devices can be predicted by the theoretical method.

(i) Explain and formulate the Mean time to failure (MTTF) of n product that fail after operating times, t_n.
(2 marks)

(ii) Based on answer **Q3(c)(i)**, formulate Mean Time Between Failure (MTBF). Then, sketch and label clearly the overall bathtub curve that contain failure rate versus time.
(3 marks)

Q4 (a) (i) Name **THREE (3)** simple and **TWO (2)** complex adhesion tests.

(5 marks)

(ii) As a student, you need to set-up a scratch test for your thin film sample. Sketch the diagram of your experiment apparatus and explain briefly.

(5 marks)

(iii) From your opinion, evaluate why test in part **Q4(a)(ii)** must be carried out.

(4 marks)

(iv) Other than scratch test, identify **ONE (1)** familiar test used in industrial site.

(2 marks)

(b) As your final year project task, you need to do measurement for detection of shallow-level impurities of your sample.

(i) Suggest the most suitable technique for your measurement.

(2 marks)

(ii) Select **ONE (1)** of III-IV group element with direct bandgap material for your experiment and explain briefly using band diagram.

(4 marks)

(iii) Analyze the strength and weakness of your proposed measurement technique in **Q4(b)(i)**.

(3 marks)

- END OF QUESTIONS -