UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION (TAKE HOME) SEMESTER II SESSION 2020/2021

COURSE NAME	:	MICROFABRICATION
COURSE CODE	:	BED40603/BEJ43203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2021
DURATION	:	4 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS OPEN BOOK EXAMINATION

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

Q1 (a) As an Engineer, you need to set-up cleanroom for microfabrication process. Sketch a basic layout of typical semiconductor fabrication processing area. In your sketch, list and describe **THREE (3)** important elements in the cleanroom.

(5 marks)

(b) With the aid of diagram(s), explain the silicon crystal structure types listed below:

(i) Single crystal

(2 marks)

(ii) Amorphous

(2 marks)

(c) Draw the silicon crystal planes with <100>, <110> and <111> Miller indices.

(3 marks)

(d) In general, more than ten steps involve during the fabrication of transistor. With the help of wafer cross-sectional drawing, investigate step-by-step formation of a single layer N-channel Metal Oxide Semiconductor (NMOS) transistor on p-type silicon wafer substrate with description of main process steps.

(12 marks)

(e) Wet oxidation and dry oxidation are two methods of oxidation for integrated circuit fabrication.

(i) Differentiate between wet oxidation and dry oxidation.

(4 marks)

(ii) Express the chemical reaction equation for both oxidation methods.

(2 marks)

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Q2 (a) State **TWO (2)** main photolithography equipment and explain their role in photolithography process.

(6 marks)

(b) Analyse **TWO (2)** elements that can contribute to the photoresist thickness during the coating process as shown in **Figure Q2(b)**.

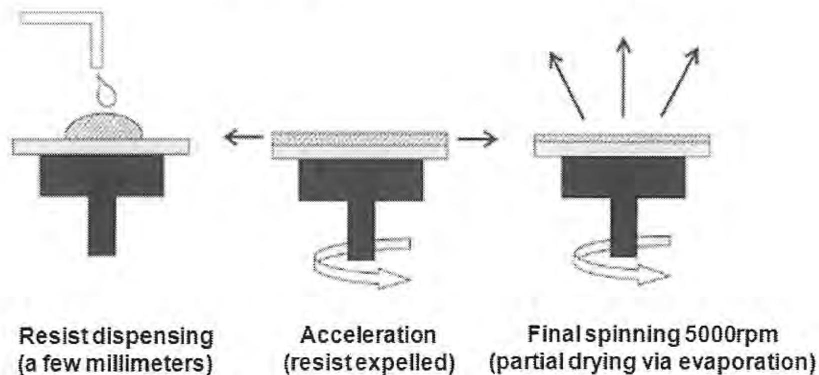

Figure Q2(b)

(4 marks)

(c) Formulate a thickness equation from the answers obtained in part **Q2(b).**

(4 marks)

(d) Photosensitive material was commonly used in lithography process. Compare **THREE (3)** differences between positive resist and negative resist. Please compare your answers in a table.

(6 marks)

Q3 (a) **Figure Q3(a)** shows a cross-section diagram for contact structure, after aluminum deposition by the sputtering technique. Given A= 6000 Å, B= 3000 Å, C= 4000 Å, D=12000 Å and E=36000 Å.

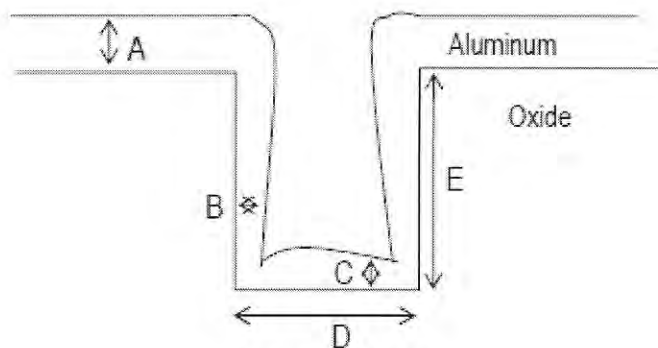

Figure Q3(a)

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Based on **Figure Q3(a)**,

(i) determine the aspect ratio for the contact structure.

(2 marks)

(ii) determine the sidewall and bottom step coverage for aluminum.

(4 marks)

(iii) explain the sputtering deposition process for aluminium with the aid of appropriate diagram.

(7 marks)

(b) As a researcher, you have to decide the lab equipment to investigate the topological properties of your thin film. Select the equipment needed and explain the properties of the equipment briefly.

(7 marks)

Q4 (a) Diffusion is a process where an exact amount of impurities/dopant atoms is introduced into the semiconductor (Si) material under specific process conditions.

(i) Explain clearly **TWO (2)** atomic diffusion mechanisms in a two- dimensional lattice using appropriate diagram.

(6 marks)

(ii) Differentiate between doping techniques namely, ion implantation and diffusion process. Support your answers with aid of diagram.

(8 marks)

(b) Etching is one of the main techniques in microfabrication to realize the pattern from mask onto silicon wafers. There are several important concepts that are associated with this technique.

(i) Analyze the etch profiles in wet and dry etching. Support your analysis with appropriate diagram.

(6 marks)

(ii) Cu_2O thin film was fabricated using electrodeposition method with initial thickness of 500nm. After 1 minute etch, the thickness was reduced to 200 nm. Calculate the etch rate of the Cu_2O thin film.

(4 marks)

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(c) (i) Differentiate between interconnects made from Aluminium (Al) and Copper (Cu). (1 mark)

(ii) Analyze the technological challenges of using copper interconnects. (5 marks)

- END OF QUESTIONS -

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