First Semester Examination
2023/2024 Academic Session

Februari 2024

EPP 351 – Advanced Manufacturing Technology
(Proses Pembuatan Termaju)

Duration: 3 hours
(Masa: 3 jam)

Please check that this examination paper consists of SIX (6) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM (6) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : Answer **ALL FIVE (5)** questions.

*[**Arahan** : Jawab **LIMA (5)** soalan]*

…2/-

1. [a] Differentiate between amorphous and crystalline polymer structure, thermoset and thermoplastic.

(20 marks)

[b] CERAMICS Sdn. Bhd. is a company specializing in production of ceramic products ranging from ceramic film, small size dinner plates to large product such as flower pot. The company needs to produce ceramic film for use as protective material in various applications. Propose ONE (1) appropriate process for production of ceramic film.

(40 marks)

[c] Using diagram, illustrate the complete process of powder metallurgy starting from the metal powder preparation until it become finished products. Justify why each stage in the process is crucial for good quality product and give TWO (2) examples of powder metallurgy products.

(40 marks)

2. [a] As Malaysia is still dependent on manufacturing based economy as it remains relevant for pushing into developed nation, but must adapt to new competitive environment in a highly connected world. Give THREE (3) justifications on why sustainable manufacturing should be adopted in the future as part of strategy to become a developed nation.

(50 marks)

[b] As a result of foreign direct investment (FDI) initiative, a multi-national company has decided to invest and begin its manufacturing of glass material in Malaysia. Sand, being the raw material for silica which is needed for glass manufacturing, need to be extracted from a remote area along a river which is an important source of livelihood for the nearby villagers.

(i) What are the THREE (3) major manufacturing sustainability performances that must be considered in this case?

(30 marks)

(ii) What would be your suggestion in order to achieve balance among the sustainability performance mentioned in [b](i)? Justify your answer.

(20 marks)

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3. [a] Component failure in high speed machinery is often associated with tiny cracks which propagate into larger cracks. Surface treatment of component may be used in order to minimize the risk of premature failure. Explain and justify an appropriate treatment method that can be used to treat the component.

(40 marks)

[b] A small beaker made of Polyurethane (PU) plastic need to be coated with uniform thin layer of Nickel to make it water proof. Two alternatives for coating the beaker are electroplating and electroless plating. Judge the suitability of the processes and justify which one should be used.

(40 marks)

[c] Calculate the plating thickness, t, in electroplating a 5-mm diameter solid-metal ball using a current of 2A, and a plating time of 1.0 hour. Assume that c = 0.08. Given the volume of sphere, $V = \frac{4}{3}\pi r^3$ and plating thickness, t.

(20 marks)

4. [a] Figure 4[a] shows the seed growth defects in thin films prepared by PVD techniques.

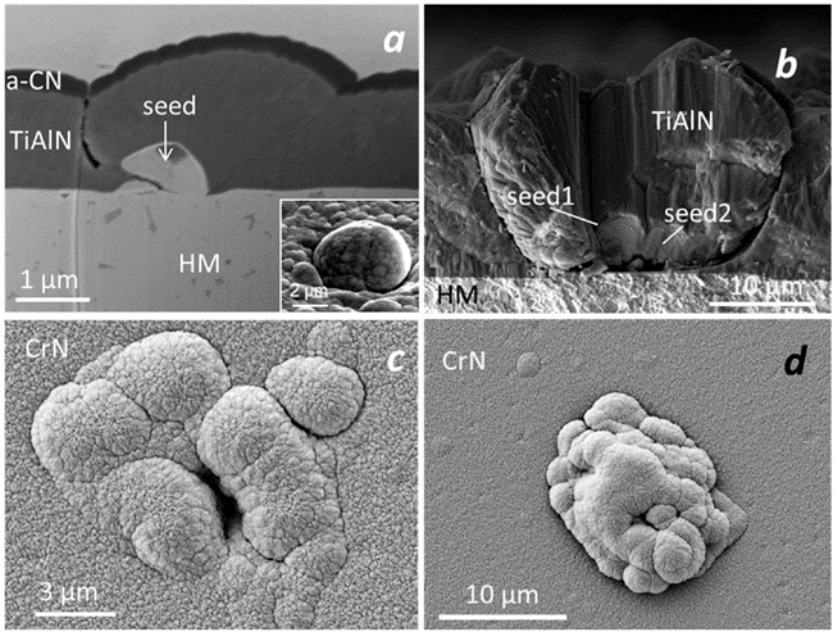

Figure 4[a]

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(i) Analyse TWO (2) harms of that defects on the film structure functionality.

(20 marks)

(ii) Suggest TWO (2) alternative techniques other than PVD to prevent the above defects and jusfy your answers.

(30 marks)

[b] (i) Lithography is the process by which the geometric patterns that define devices are transferred on to the substrate surface. Differentiate TWO (2) main characteristics between photolithography and electron beam lithography.

(20 marks)

(ii) Obtaining higher resolution images through conventional lithography is the main difficulty in developing sub-22 nm feature on substrate surface as shown in Figure 4[b] below. Suggest ONE (1) photo exposure lithography technique and through sketches, explain that process in detail.

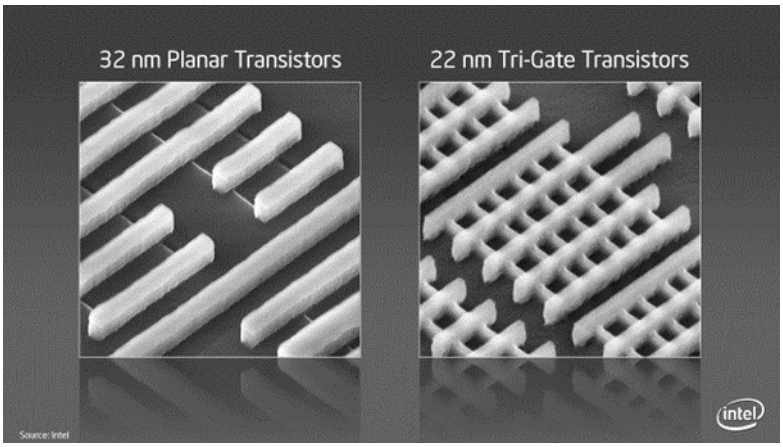

Figure 4[b]

(30 marks)

5. [a] Comb-drive is an electromechanical actuator, having set of fixed and movable comb fingers which are interdigitated with each other, and they are fixed, and movable electrodes respectively as shown in Figure 5[a]. When external power supply is given to actuator, due to generated electrostatic attraction force, a micro-tilting movement occurs, and it is used to do switching or scanning functions.

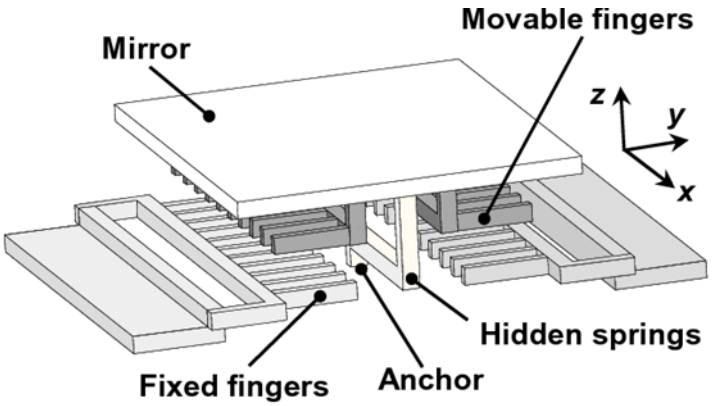

Figure 5[a]

(i) Identify ONE (1) appropriate technique to fabricate the above comb-drive structure and justify your selection.

(10 marks)

(ii) Based on your answer in question 5[a](i), illustrate the general steps of that microfabrication techniques using sketches.

(40 marks)

[b] (i) Products as shown in Figure 5[b] have been produced using LIGA and HEXSIL microfabrication processes. Based on your judgement, what are TWO (2) similarities between those two processes which made them preferable to produce the products.

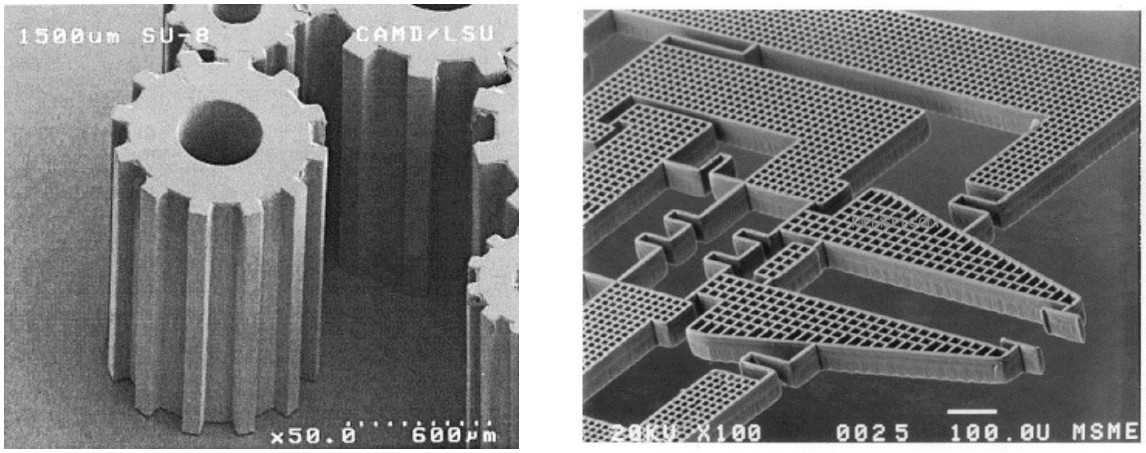

Figure 5[b]

(20 marks)

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(ii) The main disadvantage of LIGA is the need of high-energy X-rays that can only be achieved with a synchrotron to develop the PMMA structure. This and the expensive X-ray masks needed for exposure make the cost for the process high. If LIGA process is still preferable, suggest TWO (2) methods that can be applied to reduce the process cost and justify your answer.

(30 marks)

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