Second Semester Examination
2020/2021 Academic Session

July/August 2021

EPE 442 – ADVANCED SEMICONDUCTOR MANUFACTURING TECHNOLOGY

Duration : 2 hours (2+2 hour for Asynchronous)

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

Instructions : Answer ALL **FOUR (4)** questions.

Answer to each question must begin from a new page.

1. [a] WASHINGTON - April 30, 2021 - The Semiconductor Industry Association (SIA) today announced worldwide sales of semiconductors totaled $123.1 billion during the first quarter of 2021, an increase of 3.6% over the previous quarter and 17.8% more than the first quarter of 2020. Global sales for the month of March 2021 were $41.0 billion, an increase of 3.7% compared to the previous month. SIA represents 98% of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms. Regionally, year-to-year sales increased across all markets: China (25.6%), Asia Pacific/All Other (19.6%), Japan (13.0%), the Americas (9.2%), and Europe (8.7%). Month-to-month sales increased in Europe (5.8% percent), China (5.3%), Asia Pacific/All Other (3.4%), Japan (3.1%), and the Americas (0.6%). (*source: Semiconductor Industry Association www.semiconductors.org*)

Semiconductor industry is still growing strong despite COVID-19 pandemic around the globe. Many semiconductor product shortages in supply at every part of the world. Discuss THREE (3) factors that attributed to the strength of semiconductor industry even with the current acid test.

(3 marks)

[b] “The Chip Industry Has a Problem With Its Giant Carbon Footprint: Each new generation of semiconductors requires more energy, water and greenhouse gases to create”.

April 9, 2021 - Information and computing technology is expected to account for as much as 20% of global energy demand by 2030, with hardware responsible for more of that footprint than the operation of a system, they found. “Chip manufacturing, as opposed to hardware use and energy consumption, accounts for most of the carbon output,” the researchers concluded. (source: Bloomberg Green www.bloomberg.com/news/articles/2021-04-08/.)

Figure 1 [b] shows the trend of pollution by chip makers as compared a car maker. Suggest to the semiconductor industry on what they should do in term of environment and sustainability. Compose FOUR (4) suggestions with appropriate examples to them.

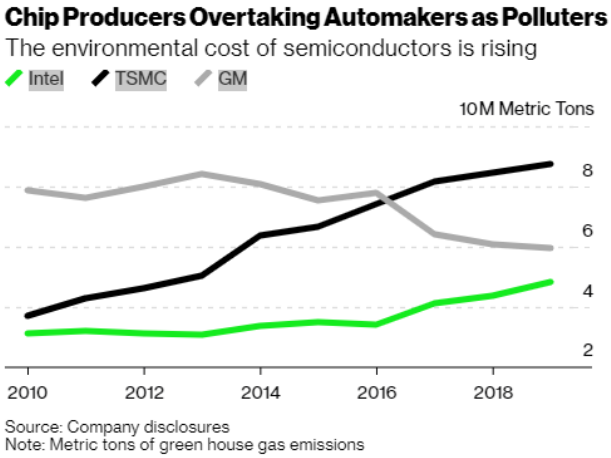


Figure 1 [b]

(4 marks)

[c] Semiconductor industry employs clean room facilities to reduce the risk of product or process contamination from a variety of compounds.

(i) Briefly describe THREE (3) of the most common types or sources of contaminants.

(ii) Discuss on how to minimize each of them.

(3 marks)

2. [a] As a semiconductor process engineer in Thin Film department, you are given a task to provide process specification for fabricating a device with specific cross-sectional device structure as shown in Figure 2[a]. Construct the appropriate process steps of achieving this device structure and provide the details of each of the processes.

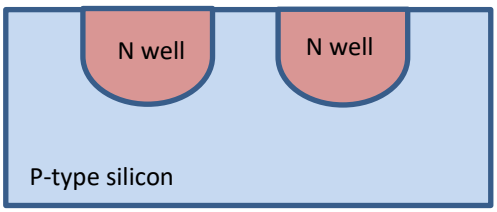
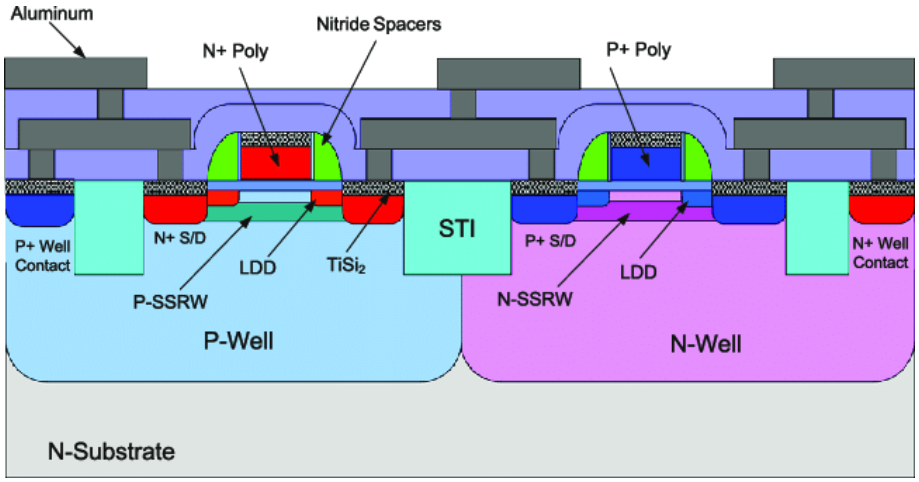


Figure 2 [a]

(5 marks)

[b] Shallow trench isolation (STI), also known as box isolation technique, is an integrated circuit feature which prevents electric current leakage between adjacent semiconductor device components. STI as shown in Figure 2[a] is generally used on CMOS process technology nodes of 250 nanometers and smaller. Construct a process flow in achieving STI structure complete with insulating material deposition.



(source: M. Hossain and M. Chowdhury, Microelectron J, 52, 2016)

Figure 2 [b]

(5 marks)

3. [a] Define anisotropic etching and isotropic etching with an appropriate cross-sectional structure diagram

(2 marks)

[b] Figure 3[b] shows an SEM image of silicon trench microstructure coated with a few nanometer thick (uniform thickness) of Alumina. Explain on how to obtain this type of coating.

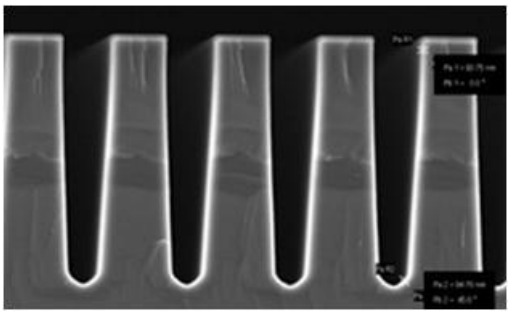


Figure 3[b]

(4 marks)

[c] As shown in Figure 3[c] left, a bare Si (100) wafer is oxidized for 1 hour at temperature 1100 °C in dry oxygen. It is then photomasked and has the oxide removed over half of the wafer. The whole wafer is then re-oxidized in steam at temperature 1000 °C for 30 minutes. Use the oxidation charts in Figure 3[c] right hand side to estimate the final oxide thickness in Region A and Region B.

(4 marks)

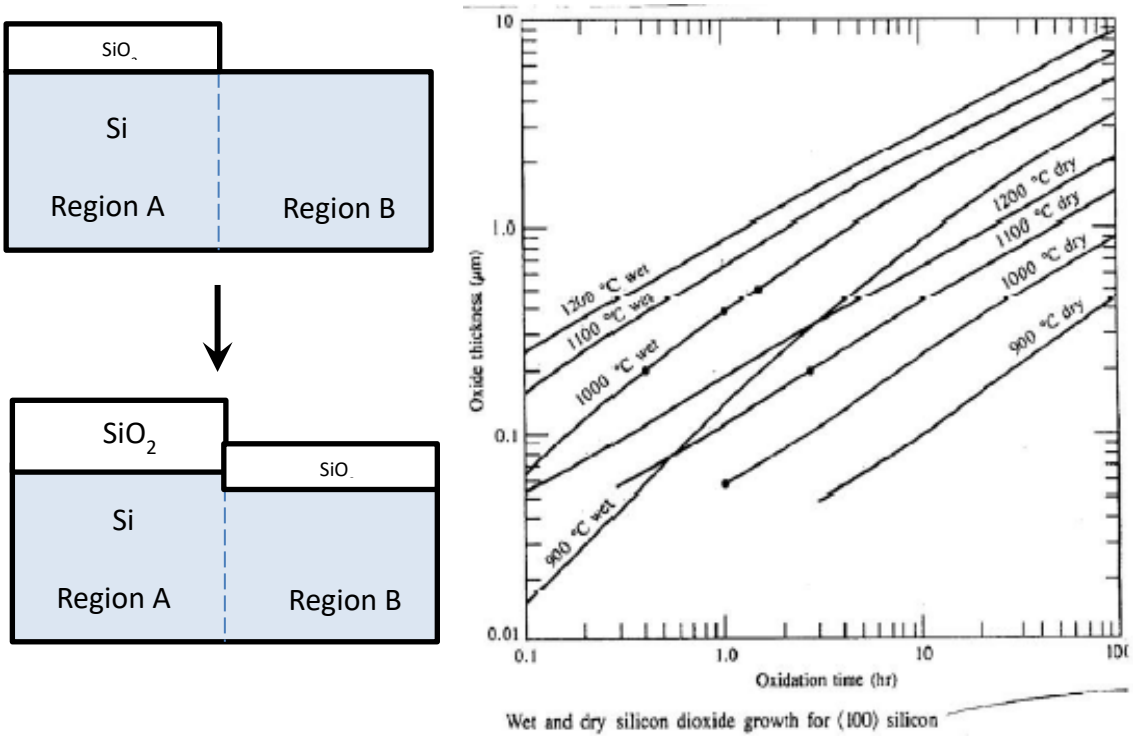


Figure 3[c]

4. [a] Describe recent advances in flexible and printed electronics. List FOUR (4) advantages of flexible circuit as compared to current rigid printed circuit board (PCB) technology.

(4 marks)

[b] Figure 4[b] shows double sided printed circuit board (PCB) product with many Surface Mount and Through Hole components mounted on both sides. Propose a manufacturing process flow in producing this product. Provide details of each step.

(6 marks)

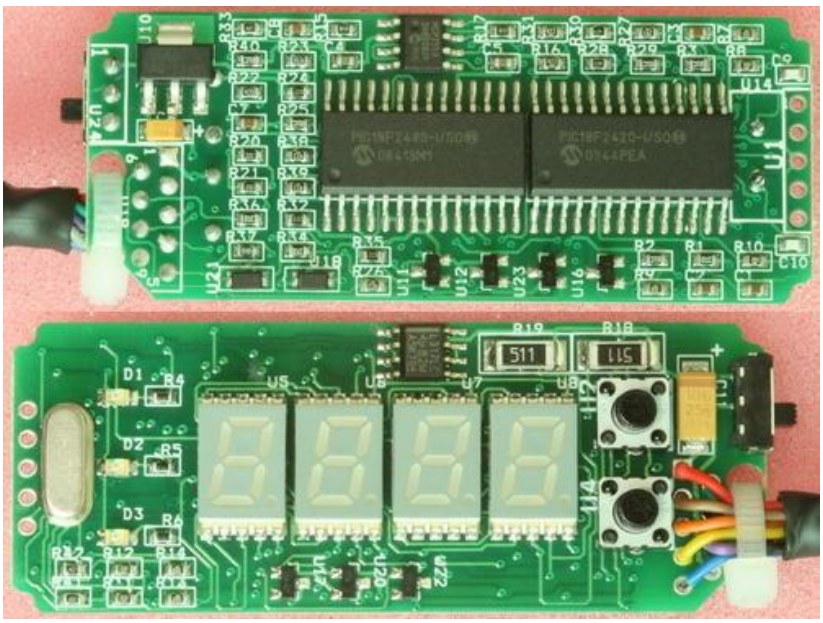


Figure 4 [b]

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