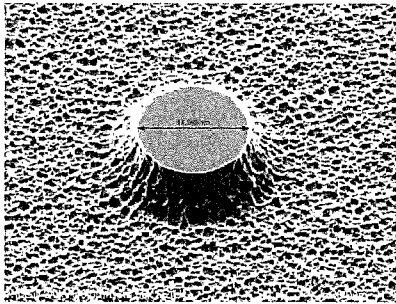


5) What are the primary and secondary flats are used for in silicon wafers. (5 points)

6) Name two advantages of flip-chip bonding as compared to wire bonding. (5 points)

7) What dry etch chemistry was used to etch the structure shown below? Explain why you chose???(5 points)



8) What is an anti-body and how does it help in improving biosensor selectivity? (5 points)

9) A simple expression for yield in IC and MEMS manufacturing is $Y=Y_0e^{-DA}$, what D and A represent in this equation? What are their units? (5 points)

10) Give an estimate of the dimensions of the following biological molecules or organisms (5 points)

- Diameter of a DNA molecule
- A typical protein molecule like hemoglobin or antibody
- A virus like flu
- A bacterial like E. coli
- A mammalian cell

Write in Exam Book Only

- A) Nano-pore sequencing has attracted a considerable attention recently as a way to sequence genome at low cost and high speed.
- Explain how this works.
 - What is the required size of the hole for sequencing applications?
 - Nanopores can be created using natural ion channels or microfabricated nanopores in inorganic materials such as SiO_2 , explain how each one is made? What are the advantages and disadvantages of each?
 - Draw the electrical output waveform resulting from translocation of a DNA strand through the pore.
 - What are the technical challenges facing this method of gene sequencing?
- (25 Points)**

B) Figure below shows stress strain curve for three different materials (brittle, general elastic material, and soft rubber) identify each one on the graph. Explain your rationale for each. For each, give an example from the materials used in MEMS and BioMEMS devices (**10 points**)



C) Figure below shows a corrugated membrane with central boss designed for a pressure sensor (top one shows circular corrugation and bottom one shows rectangular ones). What are the advantages of corrugation and boss in such sensors, i.e., what is the rationale behind their choice as compared to a simple membrane? Propose a fabrication process to make this structure assume the boss and rim are silicon and membrane is silicon nitride. How many masks do you need? (15 points)

