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# Deposition Overview for Microsystems

## Knowledge Probe

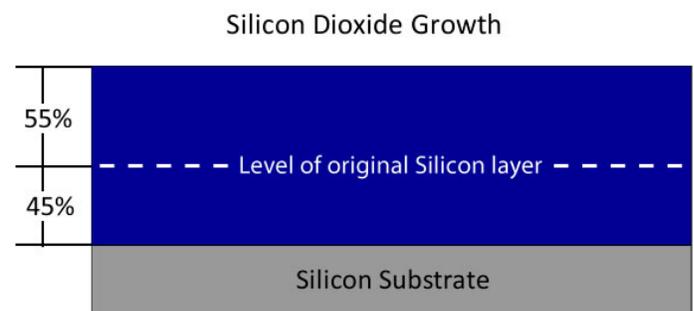
### Participant Guide

*The purpose of this learning module is to introduce you to the common processes used to deposit thin films in the fabrication of micro-size devices. Activities provide further exploration into these processes as well as the properties of the thin films deposited.*

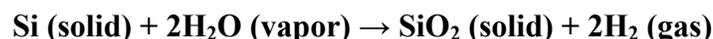
This knowledge probe is a pre-assessment to determine your current knowledge and understanding of the various types of deposition processes used in the fabrication of microsystems. There are 25 questions. Answer them to the best of your knowledge.

1. Which of the following BEST describes the purpose of the deposition process?
  - a. To grow a high quality, insulating thin film on the surface of the wafer
  - b. To deposit a high quality, conductive thin film on the surface of the wafer
  - c. To deposit or grow a high quality thin film on the surface of the wafer.
  - d. To deposit a solid layer of photoresist on the surface of the wafer.
2. Polysilicon is a thin film used in many MEMS applications. This film is used for which of the following layers in the fabrication of a MEMS?
  - a. Structural and Piezoresistive layer
  - b. Sacrificial and masking layer
  - c. Masking and Piezoresistive layer
  - d. Electrical and environmental isolation
3. Silicon dioxide is another thin film used in many MEMS applications. This film is used for which of the following layers?
  - a. Structural and Piezoresistive layer
  - b. Sacrificial and masking layer
  - c. Masking and Piezoresistive layer
  - d. Electrical and environmental isolation
4. Active piezoresistive and sacrificial applications normally require \_\_\_\_\_ thin films.
  - a. Silicon nitride
  - b. Polysilicon
  - c. Phosphosilicate Glass (PSG)
  - d. Metal or metal alloy
  - e. Photoresist
5. Metals are normally deposited using which of the following deposition processes?
  - a. Spin-on
  - b. Thermal oxidation
  - c. Physical vapor deposition
  - d. Chemical vapor deposition

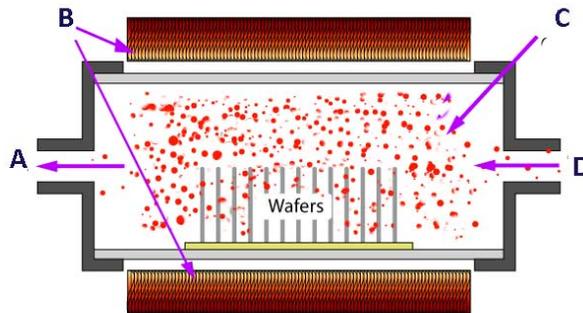
6. Which of the following deposition processes is the MOST widely used process for the deposition of thin films such as silicon nitride, silicon dioxide and polysilicon?
- Spin-on film
  - Oxidation
  - Chemical vapor deposition
  - Physical vapor deposition
  - Electroplating
7. Which deposition process “grows” the thin film rather than “deposits” it?
- Oxidation
  - CVD
  - Sputtering
  - Evaporation
8. Thermal oxidation is used for which of the following thin films on silicon?
- Silicon nitride
  - Silicon dioxide
  - Polysilicon
  - Aluminum
9. Which of the following statements BEST describes the graphic below?
- To achieve a high quality silicon dioxide ( $\text{SiO}_2$ ) film, you must first remove some of the silicon substrate (approximately 45% of the desired  $\text{SiO}_2$  thickness).
  - The thermal oxidation process uses a high temperature step to remove some of the silicon substrate (approximately 45% of the desired  $\text{SiO}_2$  thickness) before growing  $\text{SiO}_2$ .
  - In a thermal oxidation process, the bottom 45% of the  $\text{SiO}_2$  layer has a higher concentration of silicon than the top 55%.
  - In a thermal oxidation reaction the amount of silicon substrate consumed is 45% of the final oxide thickness.



10. The following formula is a reaction that takes place in a specific type of deposition process. In which deposition process does this reaction occur?
- Silicon nitride CVD
  - Wet oxidation of silicon dioxide
  - Dry oxidation of silicon dioxide
  - Spin-on of photoresist



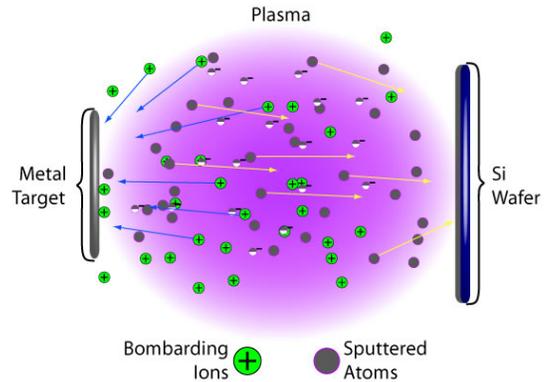
11. The films deposited during chemical vapor deposition (CVD) are a result of two types of chemical reactions: homogeneous and heterogeneous. A heterogeneous reaction is between
  - a. the reactive gases or reactants used in the process
  - b. the reactants and the atoms on the substrate surface
  - c. both the reactants and reactants with the atoms on the substrate surface
  
12. The following diagram represents a low pressure CVD system. Match the labels (A,B,C,D) to the components/process elements, respectively?
  - a. Reaction chamber, heating elements, reactants, vacuum/exhaust
  - b. Reactants, vacuum/exhaust, heating elements, reaction chamber
  - c. Vacuum/exhaust, heating elements, reaction chamber, reactants
  - d. Reactants, heating elements, reaction chamber, vacuum/exhaust



13. In a CVD process, which of the following is NOT a process parameter that affects the resulting film thickness and quality?
  - a. Pressure
  - b. Temperature
  - c. Reactant flow rate
  - d. Reactant concentration
  
14. What does the acronym PECVD represent?
  - a. Pressure-enhanced chemical vapor deposition
  - b. Plasma-enhanced chemical vapor deposition
  - c. Partial evaporation chemical vapor deposition
  - d. Plating electronically chemical vapor deposition
  
15. Which of the following deposition processes is used when a film needs to be deposited on both sides of the wafer?
  - a. LPCVD
  - b. PECVD
  - c. Evaporation
  - d. Sputtering
  - e. Spin-on

16. What is the difference between HDPECVD and PECVD?
- PECVD uses a plasma whereas HDPECVD uses only a magnetic field
  - PECVD uses a low pressure chamber whereas HDPECVD uses a high pressure chamber
  - HDPECVD uses a magnetic field to increase the density of the plasma in PECVD
  - HDPECVD uses a higher pressure to increase the density of the plasma in PECVD
17. \_\_\_\_\_ systems operate at temperature higher than 600° C, compared to \_\_\_\_\_ systems which operate at lower temperatures down to 300°C.
- APCVD, LPCVD
  - LPCVD, APCVD
  - PECVD, APCVD
  - LPCVD, PECVD
18. Sputtering and evaporation are deposition processes used primarily to deposit what type of films?
- Silicon nitride
  - Polysilicon
  - SOG
  - Silicon dioxide
  - Metals and metal alloys
19. Which of the following BEST describes the sputtering process?
- A high heat source is used to vaporize the material to be deposited. This vapor is then accelerated towards the wafer surface where it solidifies.
  - A plasma is used to generate high energy ions that bombard a target, causing target atoms to break off as a vapor which expands and condenses on all surfaces, including the substrate.
  - A plasma is used to generate high energy ions that bombard a source, causing atoms to vaporize, deposit on the substrate and solidify.
  - Low pressure, high energy molecules collide, creating ions used to react with substrate surface atoms causing these atoms to break apart from the substrate
20. Which of the following processes uses a high heat source to vaporize a source material consisting of the elements of the desired thin film?
- LPCVD
  - PECVD
  - Evaporation
  - Sputtering
  - Thermal oxidation

21. Which of the following processes is illustrated by the graphic?
- LPCVD
  - PECVD
  - Evaporation
  - Sputtering



22. Which of the following microsystems processes is BEST for depositing relatively thick films of metal?
- CVD
  - Sputtering
  - Evaporation
  - Electrodeposition
  - Spin-on
23. Which of the following is a unique characteristic of the oxidation process?
- Uses ion bombardment on a target
  - Grows oxide on silicon
  - Used to deposit a film on both sides of the wafer
  - Requires an electrically conductive substrate
  - Melts the source material forming a vapor
24. Which of the following is a unique characteristic of the electroplating process?
- Uses ion bombardment on a target
  - Grows oxide on silicon
  - Used to deposit a film on both sides of the wafer
  - Requires an electrically conductive substrate
  - Melts the source material forming a vapor
25. Which of the following is a unique characteristic of the evaporation process?
- Uses ion bombardment on a target
  - Grows oxide on silicon
  - Used to deposit a film on both sides of the wafer
  - Requires an electrically conductive substrate
  - Melts the source material forming a vapor

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