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# Deposition Overview for Microsystems

## Final Assessment

### Instructor Guide

#### Notes to Instructor

This assessment contains 25 questions for a final assessment for the Deposition Overview for Microsystems. All are multiple choice questions.

The *Deposition Overview for Microsystems Final Assessment* can be used to determine the participant's knowledge of the various deposition processes used in the fabrication of microsystems. This assessment could be compared with the result from the Knowledge probe (KP) to determine the effectiveness of this learning module.

The *Deposition Overview for Microsystem Learning Module* consists of the following.

- Knowledge Probe (KP) - pretest
- Deposition Overview for Microsystems PK
- Deposition Terminology Activity
- Science of Thin Films Activity (Supporting SCME Kit available)
- Activity – What Do You Know About Deposition?
- **Final Assessment**

This Instructor Guide (IG) contains both the questions and answers for the 25 questions.

The purpose of this assessment is to determine your understanding of the various types of deposition processes used in the fabrication of microsystems. There are 25 questions.

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.

*Answer: c. To deposit or grow a high quality, thin film 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
  - e. Active Piezoresistive and sacrificial layer

*Answer: a. structural and piezoresistive material*

3. Silicon dioxide is another thin film used in many MEMS applications. This film is used for which of the following purposes?
  - a. Structural and Piezoresistive layer
  - b. Sacrificial and masking layer
  - c. Masking and Piezoresistive layer
  - d. Electrical and environmental isolation
  - e. Active Piezoresistive and sacrificial layer

*Answer: b. sacrificial and masking layer*

4. Metals are also used for MEMS applications. What are the purposes of metals in MEMS fabrication?
  - a. Structural and Piezoresistive layer
  - b. Sacrificial and masking layer
  - c. Masking and Piezoresistive layer
  - d. Electrical and environmental isolation
  - e. Active Piezoresistive and sacrificial layer

*Answer: e. Active Piezoresistive and sacrificial layer*

5. Spin-on deposition is the process of literally spinning a liquid onto the surface of the wafer. Which of the following thin films is primarily deposited using spin-on deposition?
- a. Photoresist
  - b. Silicon nitride
  - c. Silicon dioxide
  - d. Polysilicon
  - e. Metals

**Answer: a. Photoresist**

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?
- a. Spin-on film
  - b. Oxidation
  - c. Chemical vapor deposition
  - d. Physical vapor deposition
  - e. Electroplating

**Answer: c. chemical vapor deposition**

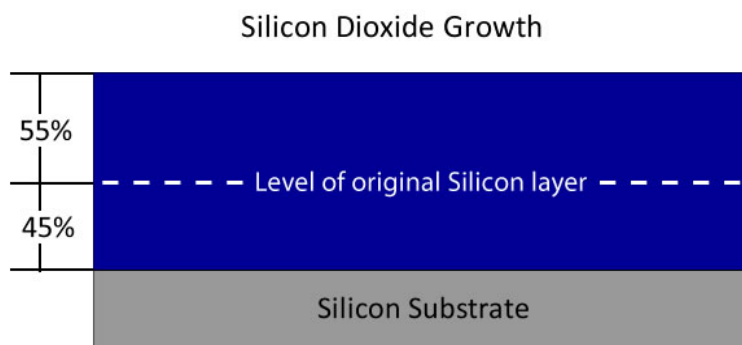
7. The deposition process that “grows” a thin film on substrate surface using heat and vapor is called \_\_\_\_\_.
- a. Thermal Wet Oxidation
  - b. Thermal Dry Oxidation
  - c. Chemical Vapor Deposition
  - d. Physical Vapor Deposition
  - e. Electrodeposition

**Answer: a. Thermal Wet Oxidation**

8. Thermal oxidation is used for which of the following thin films?
- a. Silicon nitride
  - b. Silicon dioxide
  - c. Polysilicon
  - d. Aluminum

**Answer: b. silicon dioxide**

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.



**Answer: d.** 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

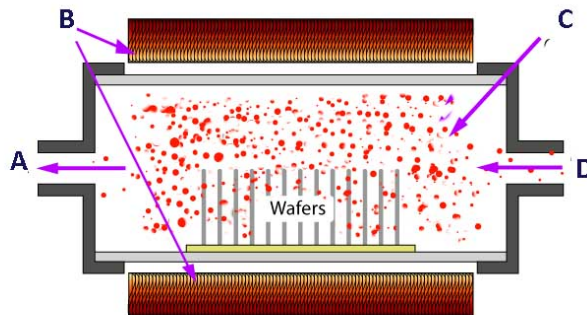


**Answer: c.** Dry oxidation of silicon dioxide

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
- the reactive gases or reactants used in the process
  - the reactants and the atoms on the substrate surface
  - both the reactants and reactants with the atoms on the substrate surface

**Answer: b. the reactants and 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?
- Reaction chamber, heating elements, reactants, vacuum/exhaust
  - Reactants, vacuum/exhaust, heating elements, reaction chamber
  - Vacuum/exhaust, heating elements, reaction chamber, reactants
  - Reactants, heating elements, reaction chamber, vacuum/exhaust



**Answer: c.**

13. In a CVD process, which of the following is NOT a process parameter that affects the resulting film thickness and quality?
- Pressure
  - Temperature
  - Reactant flow rate
  - Reactant concentration

**Answer: c. Reactant flow rate**

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

**Answer: b. Plasma-enhanced 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

**Answer: a. LPCVD**

16. What is the difference between HDPECVD and PECVD?
- a. PECVD uses a plasma whereas HDPECVD uses only a magnetic field
  - b. PECVD uses a low pressure chamber whereas HDPECVD uses a high pressure chamber
  - c. HDPECVD uses a magnetic field to increase the density of the plasma in PECVD
  - d. HDPECVD uses a higher pressure to increase the density of the plasma in PECVD

**Answer: c. HDPECVD uses a magnetic field 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.
- a. APCVD, LPCVD
  - b. LPCVD, APCVD
  - c. PECVD, APCVD
  - d. LPCVD, PECVD

**Answer: d. LPCVD, PECVD**

18. Sputtering and evaporation are deposition processes used primarily to deposit what type of films?
- a. Silicon nitride
  - b. Polysilicon
  - c. SOG
  - d. Silicon dioxide
  - e. Metals and metal alloys

**Answer: e.**

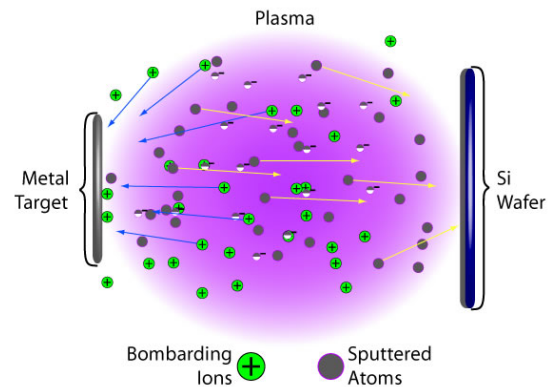
19. Which of the following BEST describes the sputtering process?
- a. A high heat source is used to vaporize the material to be deposited. This vapor is then accelerated towards the wafer surface where it solidifies.
  - b. A plasma is used to generate high energy ions that bombard a target, causing target atoms to break off as a vapor which expands and condenses on all surfaces, including the substrate.
  - c. A plasma is used to generate high energy ions that bombard a source, causing atoms to vaporize, deposit on the substrate and solidify.
  - d. Low pressure, high energy molecules collide, creating ions used to react with substrate surface atoms causing these atoms to break apart from the substrate.

**Answer: b.**

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?
- a. LPCVD
  - b. PECVD
  - c. Evaporation
  - d. Sputtering
  - e. Thermal oxidation

**Answer: c. Evaporation**

21. Which of the following processes is illustrated by the graphic?
- a. LPCVD
  - b. PECVD
  - c. Evaporation
  - d. Sputtering
  - e. c and d



**Answer: d. Sputtering**

22. Which of the following microsystems processes is best for depositing relatively thick films of metal?
- a. CVD
  - b. Sputtering
  - c. Evaporation
  - d. Electrodeposition
  - e. Spin-on

**Answer: d. electrodeposition**

23. Which of the following is a unique characteristic of the oxidation process?
- a. Uses ion bombardment on a target
  - b. Grows oxide on silicon
  - c. Used to deposit a film on both sides of the wafer
  - d. Requires an electrically conductive substrate
  - e. Melts the source material forming a vapor

***Answer: b. grows oxide on silicon***

24. Which of the following is a unique characteristic of the electrodeposition process?
- a. Uses ion bombardment on a target
  - b. Grows oxide on silicon
  - c. Used to deposit a film on both sides of the wafer
  - d. Requires an electrically conductive substrate
  - e. Melts the source material forming a vapor

***Answer: d. requires an electrically conductive substrate***

25. Which of the following is a unique characteristic of the evaporation process?
- a. Uses ion bombardment on a target
  - b. Grows oxide on silicon
  - c. Used to deposit a film on both sides of the wafer
  - d. Requires an electrically conductive substrate
  - e. Melts the source material forming a vapor

***Answer: e. melts the source material forming a vapor***

*Support for this work was provided by the National Science Foundation's Advanced Technological Education (ATE) Program through Grants. For more learning modules related to microtechnology, visit the SCME website (<http://scme-nm.org>).*