

**Southwest Center for Microsystems Education (SCME)
University of New Mexico**

MEMS Micromachining Overview Learning Module

This learning module contains the following:

Knowledge Probe (KP) or Pre-test

Primary Knowledge (PK)

Terminology Activity

Research Activity

Final Assessment

This learning module provides an overview of three micromachining processes (bulk, surface, LIGA) used for the fabrication of microsystems or MEMS (microelectromechanical systems). Activities are provided that contribute to a better understanding of these processes and that encourage further exploration.

Target audiences: High School, Community College, Universities

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Website: www.scme-nm.org

MEMS Micromachining Overview

Knowledge Probe (Pre-test)

Participant Guide

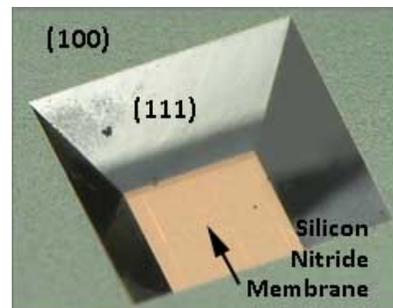
Objective of this Knowledge Probe (KP)

This learning module provides an overview of three micromachining processes (bulk, surface, LIGA) used for the fabrication of microsystems or MEMS (microelectromechanical systems). Activities are provided that contribute to a better understanding of these processes and that encourage further exploration.

This knowledge probe helps to determine your current knowledge and understanding of three common types of MEMS micromachining processes. This KP should help you identify areas in which you need a better understanding and also assist the instructor in knowing what needs to be emphasized.

Answer the following questions to the best of your knowledge. Don't worry if you don't know the answer. Select the answer that you "think" is correct.

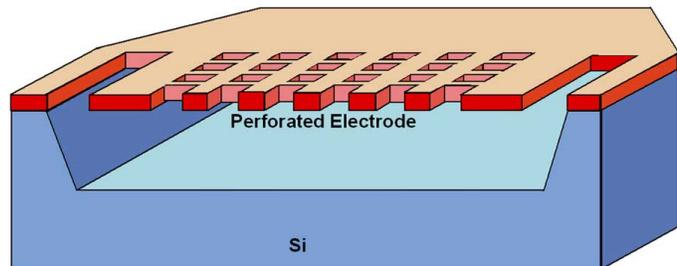
1. Which of the following is NOT a widely used micromachining process?
 - a. Bulk
 - b. Surface
 - c. PMMA
 - d. LIGA
2. Which micromachining process would be used to construct the microchannels and chambers into a wafer's substrate?
 - a. Bulk
 - b. Surface
 - c. PMMA
 - d. LIGA
3. Which crystalline plane etches faster?
 - a. 100
 - b. 111
 - c. They etch at the same rate



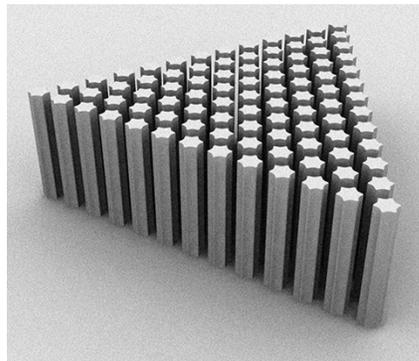
4. Which of the following statements BEST describes the difference between bulk and surface micromachining?
 - a. Bulk micromachining uses sacrificial layers alternated with structural layers. The sacrificial layers are bulk etched. Surface micromachining builds MEMS into the surface of the silicon substrate.
 - b. Bulk micromachining builds structures into the silicon substrate. Surface micromachining builds structures on the top of the substrate by depositing and etching alternating sacrificial and structural layers.
 - c. Bulk micromachining is the best micromachining process for building high aspect ratio structures. Surface micromachining is the best micromachining process for building low aspect ratio structures.
 - d. Bulk micromachining has faster etch rates than surface micromachining; therefore, bulk is better for etching into the substrate.

5. Which of the following MEMS components would NOT be fabricated using bulk micromachining processes?
 - a. Cantilevers
 - b. Microfluidic channels
 - c. Probes
 - d. Gear trains

6. Which micromachining process or combined processes were used to fabricate the following MEMS device?
 - a. Bulk only
 - b. Surface only
 - c. LIGA only
 - d. Bulk and Surface
 - e. Bulk and LIGA



7. Which micromachining process would be best for fabricating these high aspect ratio single posts?
 - a. Bulk
 - b. Surface
 - c. LIGA
 - d. Bulk and Surface
 - e. Bulk and LIGA



8. Which micromachining process would be best for fabricating low aspect ratio combdrives?
 - a. Bulk
 - b. Surface
 - c. LIGA
 - d. Bulk and Surface
 - e. Bulk and LIGA

9. Which micromachining process would be used to produce a mold that could be used to mass produce plastic micro-sized parts?
 - a. Bulk
 - b. Surface
 - c. LIGA
 - d. Bulk or LIGA
 - e. Any of the above

10. Which of the following statements is NOT true?
 - a. Isotropic etching is a chemical process; anisotropic etching can be either a chemical or physical process.
 - b. Anisotropic etching is used to fabricate V-shaped grooves, nozzles, and straight wall structures such as holes and channels.
 - c. Isotropic profiles require wet etch processes and anisotropic profiles require dry etch processing.
 - d. Wet isotropic etching is used to remove sacrificial layers

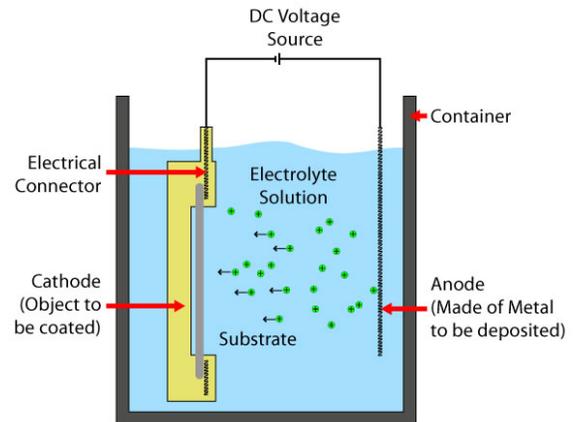
11. Which of the following micromachining processes can MOST EASILY fabricate the circuit electronics simultaneously to constructing the MEMS components?
 - a. Surface
 - b. Bulk
 - c. LIGA
 - d. Surface, bulk, and LIGA

12. With surface micromachining, a wet etch is performed once the structural layers have been deposited, patterned and etched. What is the purpose of this wet etch process?
 - a. To rid the top layer of contaminates
 - b. To smooth the topography of the top layer
 - c. To smooth the edges of the MEMS components in the structural layers
 - d. To remove the sacrificial layers

13. In surface micromachining which of the following thin films is most commonly used for structural layers?
- Silicon nitride
 - Self-assembled monolayer
 - Silicon dioxide
 - Polysilicon crystal
14. What is the purpose of chemical mechanical polishing (CMP)?
- To reduce friction or stiction of the components between structural layers
 - To rid the surface of each new layer of contaminants
 - To flatten or smooth the topography of the sacrificial layer prior to deposition of structural layer
 - To flatten or smooth the topography of the structural layer prior to deposition of the sacrificial layer
15. In the photolithography step, surface micromachining uses photoresist, while LIGA uses which of the following for a similar purpose?
- Photoresist
 - Plexiglas or PMMA
 - Beryllium
 - KOH
16. Ultraviolet light (UV) is to surface micromachining photolithography as _____ radiation is to LIGA photolithography.
- synchrotron
 - electromagnetic
 - microwave
 - infrared
17. Which step of the LIGA process results in a high aspect ratio cavity, hole or trench?
- Strip
 - Electroform
 - Expose
 - Replicate
 - Develop

18. Which step of the LIGA process is illustrated with this graphic?

- a. Strip
- b. Electroform
- c. Expose
- d. Develop



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>).