# MEMS Micromachining Terminology Activity
## Participant Guide

**Description and Estimated Time to Complete**

In this activity you demonstrate your knowledge of MEMS micromachining terminology and basic concepts. This activity consists of two parts:

- A **crossword puzzle** that tests your knowledge of the terminology and acronyms associated with three micromachining processes, and
- **Post-activity questions** that ask you to demonstrate a better understanding of micromachining and how each type applies to MEMS devices.

If you have not reviewed the unit *MEMS Micromachining Overview*, you should do so before completing this activity.

Estimated Time to Complete
Allow at least 30 minutes to complete this activity.

## Introduction

Many of MEMS fabrication processes use batch fabrication techniques where more than one wafer is processed at a time, as well as tools and infrastructure similar to that used in the manufacturing of integrated circuits (IC) or computer chips. By incorporating this existing technology, MEMS fabrication (also called micromachining) has allowed for the manufacturing of micro and nano-sized devices at lower cost and increased reliability when compared to macro-sized equivalent components. This is especially true for sensors and actuators.[1] These microdevices also tend to be quite rugged. They respond quickly while consuming little power and they occupy very small volumes.[2]

MEMS micromachining techniques allow for the construction of three-dimensional (3D) micro-sized structures, components, and various elements on or within a substrate (usually silicon). In some cases, micromachining is the utilization of modified IC manufacturing processes in conjunction with other processes such as deep bulk etching, laser assisted chemical vapor deposition, electroplating, and molding techniques.

Three widely used MEMS fabrication methods are

- surface micromachining,
- bulk micromachining, and
- LIGA (Lithography, Galvanoformung (electroforming), and Abformung (molding).

When working in the microtechnology field, it is important that you understanding the terminology associated with these three processes. This activity allows you to test your understanding.

## Activity Objectives

- Identify the correct terms used for several definitions or statements related to MEMS micromachining.
- Describe the micromachining processes required to fabricate various MEMS devices.

## Resources

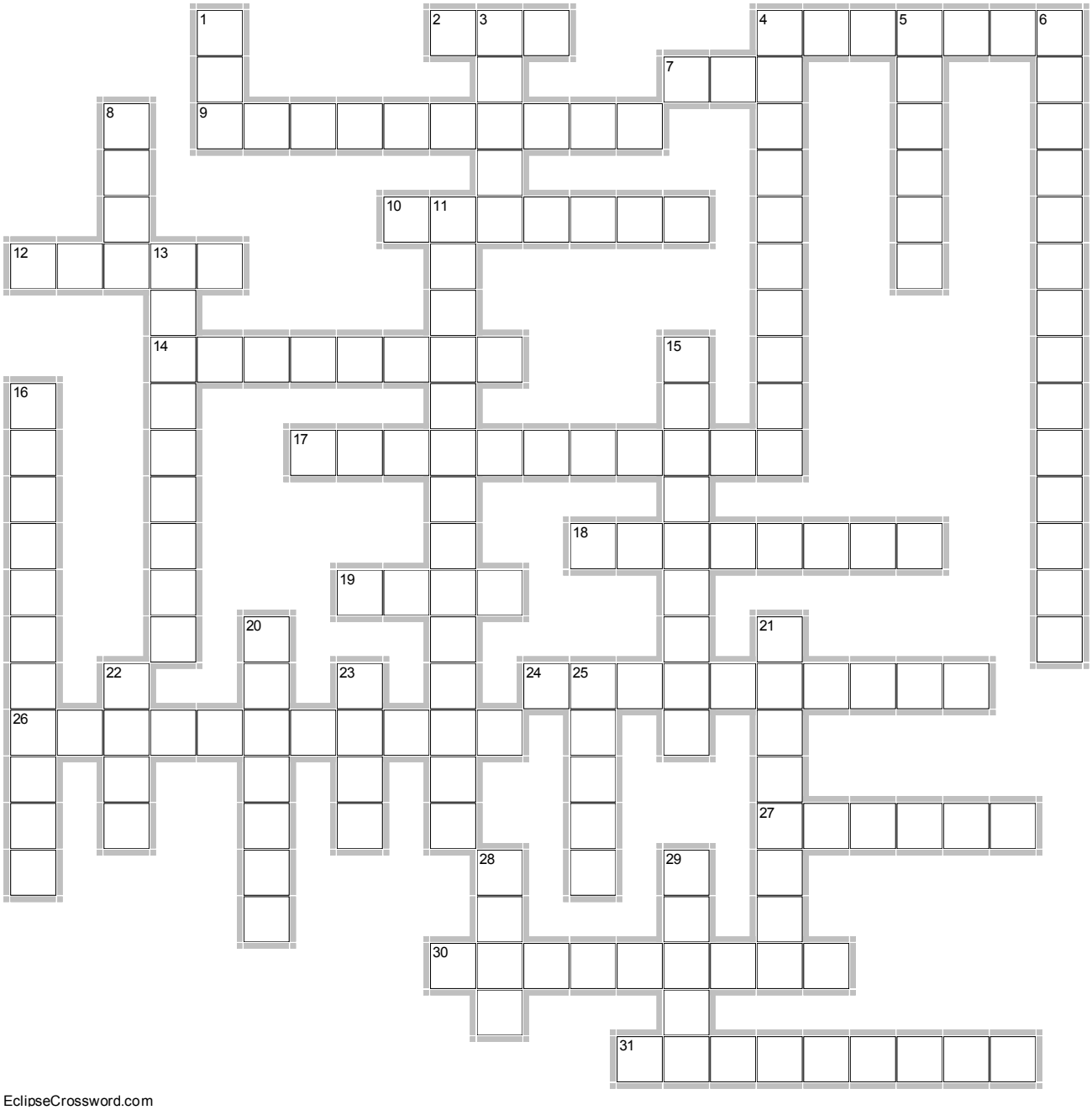
SCME's MEMS Micromachining Overview Primary Knowledge Unit

## Documentation

1. Completed Crossword Puzzle
2. Questions and Answers to the Post-Activity Questions

**Activity: MEMS Micromachining Terminology**

Procedure:
Complete the crossword puzzle using the clues on the following page.



**ACROSS**

| Question | Answer |
|---|---|
| 2. A process used to flatten the topography of the wafer's surface as new layers are deposited (acronym) | |
| 4. A micromachining process that uses layers of thin films deposited on the surface of a substrate to construct structural components for MEMS | |
| 7. The type of etch used to remove sacrificial layers | |
| 9. A process that deposits a thin film or material onto a surface | |
| 10. The purpose of removing the sacrificial layer from underneath the structural layer is to _____ the object so it can move | |
| 12. LIGA allows for the mass production of micro-devices made of metal, polymers and _____ | |
| 14. A subtractive process in which the silicon substrate is selectively removed (2 words) | |
| 17. Layer deposited between structural layers for mechanical separation and isolation | |
| 18. The sacrificial layer is to the structural layer as a _____ is to a bridge | |
| 19. A micromachining process that defines structures by selectively removing or etching inside a substrate. | |
| 24. In surface micromachining as layers are deposited and etched, the _____ of the surface becomes uneven | |
| 26. An etch profile with straight wall geometries | |
| 27. In a bulk etch, the (111) plane etches about 400 times _____ than the (100) plane | |
| 30. SAM or a self-assembled _____ is deposited to make the surface hydrophobic and to reduce friction | |
| 31. An etch profile created by chemical reaction between the etchant and underlying layer | |

| DOWN Questions | Answers |
|---|---|
| 1. Deposition process used to deposit many of the different types of layers used in surface micromachining (acronym) | |
| 3. Conductive layers are normally thin films of _____ | |
| 4. Layer having the mechanical and electrical properties needed for the component being constructed | |
| 5. In a KOH etch, the (100) plane of the substrate etches _____ than the (111) plane | |
| 6. The LIGA step used to coat an object with a metal or metal alloy | |
| 8. A photosensitive material known as acrylic glass or Plexiglas used in LIGA (acronym) | |
| 11. The process of using electrical current to coat faucets and door knobs with a layer of chrome | |
| 13. A cliff face is to cliff dwellings as the _____ is to a bulk etch | |
| 15. Process used to grow a uniform, high quality layer of silicon dioxide on the surface of a silicon substrate | |
| 16. The representation of the height of an etched feature to its width (2 words) | |
| 20. Photolithography is used to transfer a _____ from a mask to resist | |
| 21. A MEMS _____ sensor uses a silicon nitride membrane over a bulk etched chamber | |
| 22. A long involved German acronym or lithography, electroforming and molding | |
| 23. LIGA can be used to create a _____ for the mass production of a plastic micro-component | |
| 25. In surface micromachining, _____ is commonly used as a sacrificial layer and hard mask | |
| 28. Surface micromachining uses many of the same processes and tools as _____ fabrication (acronym) | |
| 29. In LIGA synchrotron radiation produces _____ to “expose” sensitive materials | |

**Post-Activity Questions**

1. Inkjet printers use microchambers and channels to store and pump ink to the print heads. What type of micromachining process is best for creating these chambers and channels?

2. Explain why surface micromachining is used for MEMS such as gear trains, combdrives, switches and gyroscopes.

3. Describe the LIGA process step(s) that yields high aspect ratio cavities.

4. What are three types or characteristics of MEMS devices fabricated using LIGA?

5. Why is chemical mechanical polishing used in surface micromachining?

6. Bulk etch is called a subtractive process and LIGA is called an additive process. Explain.

## References


1. Fabricating MEMS and Nanotechnology. MEMS Exchange. 2009. http://www.memsnet.org/mems/fabrication.html
2. A Tutorial of MEMS. Micro Fabrication Techniques. Trimmer.net™, William Trimmer, Ph.D. President of Belle Mead Research, specializing in MEMS. 2009. http://home.earthlink.net/~trimmerw/mems/index.html


## Disclaimer




*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).*