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# MEMS Micromachining Research Activity

## Instructor Guide

### Notes to Instructor

This activity provides the participants an opportunity to further explore a MEMS Micromachining application and its process. Participants should read the MEMS Micromachining Overview PK before doing this activity in order to get an understanding of what the processes are and the different types of MEMS fabricated with each process.

Participants may choose to work alone or with one other person. They also should be able to decide the type of presentation in which to present their research. This is a good activity for an outside assignment.

This activity is part of the *MEMS Micromachining Overview Learning Module*:

- Knowledge Probe (KP)
- MEMS Micromachining Overview PK
- Terminology Activity
- **Research Activity**
- LIGA Activities (4) – These activities can be found in the LIGA Micromachining Activities Module. A SCME kit is required for 2 of these activities\*.
- Final Assessment

*\*The LIGA Micromachining kit can be ordered through the SCME website (<http://scme-nm.org>) while supply lasts and center is funded.*

This companion Instructor Guide (IG) contains all of the information in the PG as well as answers to the Post-Activity questions.

## Description and Estimated Time to Complete

In this activity you will use Internet sources to study a MEMS that has been fabricated using one or more of the MEMS micromachining processes discussed in the primary knowledge unit – *MEMS Micromachining Overview PK*. You will identify applications for this MEMS and describe its step-by-step fabrication process. You will present your findings in some type of presentation such as a PowerPoint.

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

### Estimated Time to Complete

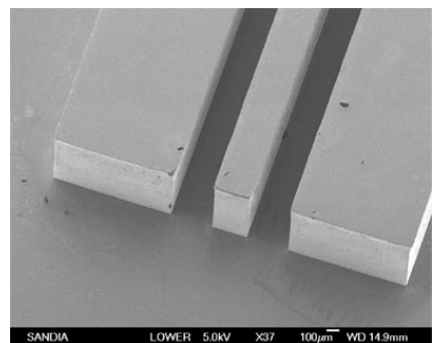
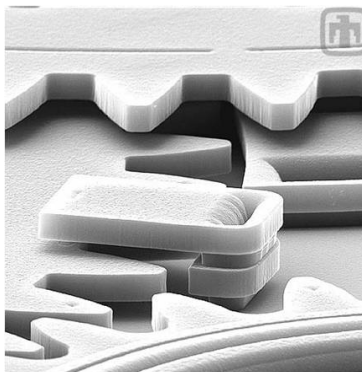
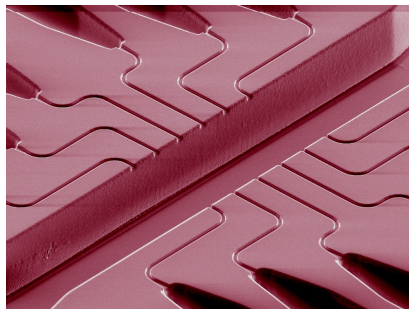
Allow at least two hours to complete this activity.

## Introduction

Three widely used MEMS micromachining methods are

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

Below are scanning electron microscope (SEM) images of products from each type of micromachining process. The far left SEM shows microchambers and channels fabricated using bulk micromachining. The middle SEM shows layers of gears made possible through surface micromachining. The right SEM is a waveguide produced by Sandia National Laboratories using LIGA. [The SEMs of the gears and waveguide are courtesy of Sandia National Laboratories. The microfluidic channels are courtesy of BioPOETS Lab, Berkeley]



Surface micromachining constructs thin mechanical components and systems on the surface of a substrate by alternately depositing, patterning and etching thin films. Bulk micromachining etches into a substrate to form 3D mechanical elements such as channels, chambers and valves. When combined with wafer bonding, surface and bulk micromachining allow for the fabrication of complex mechanical devices.<sup>2</sup> LIGA processes combine collimated x-ray lithography with electroplating and molding techniques to create high aspect ratio (tall and thin) structures or deep cavities needed for certain types of MEMS devices.

This activity allows you the opportunity to study in detail a MEMS that has been fabricated using one of these micromachining processes.

## **Activity Objectives and Outcomes**

### Activity Objectives

- Identify the applications of a specific MEMS.
- Outline and describe the steps of the micromachining process used to fabricate a specific MEMS.

### Activity Outcomes

During your research you should be able to better identify the types of micromachining processes required for different types of MEMS. You should also be able to better identify the differences and similarities between these processes.

The final outcome will be to explain the step-by-step process for the fabrication of a specific MEMS or MEMS device.

## **Resources**

Various Internet sources. Be sure to use reliable sources for your research and cite each source in your presentation when applicable.

## **Team**

This is a good project for two people in that it promotes discussion, problem solving, and organization of information.

## **Documentation**

- A PowerPoint presentation, animation, or flash that satisfies the objectives of this activity.

NOTE: Be sure to include ALL sources and references to data and graphics.

## Activity: MEMS Micromachining Research Activity

### Procedure:

1. Research the Internet for a MEMS, MEMS device or MEMS component that you find interesting. In your research, gather information on the following:
  - a. Various applications of this device (i.e., Where it is used? How it is used? Who uses it or who is affected by it?)
  - b. Images of the device
  - c. The micromachining processes and process steps required to fabricate this device. (Some of the step-by-step process may have to be inferred using your knowledge of these processes.)
  - d. A table of all references for the information and graphics that you plan to use in your presentation.
2. Organize your material for a 5 to 10 minute presentation.
3. Develop a PowerPoint, animation, flash or other type of presentation that effectively presents the results of your research and addresses this activity's objectives.
4. Present your presentation.

### 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

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