

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

MEMS Fabrication Topic

**Etch Overview for Microsystems
Learning Module**

This booklet contains six (6) units:
Knowledge Probe (KP) / pre-test
Primary Knowledge (Reading)
Etch Terminology Activity
Science of Thin Films Activity
Bulk Micromachining: An Etch Process Activity
Final Assessment

A Learning Module Map is included that is a suggested outline on how to use this learning module.

This Learning Module introduces the most common etch processes used in the fabrication of microsystems. Activities allow students to demonstrate their understanding of the terminology and basic concepts of these processes.

Target audiences: High School, Community College, University

Made possible through grants from the National Science Foundation Department of Undergraduate Education #0830384, 0902411, and 1205138.

Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and creators, and do not necessarily reflect the views of the National Science Foundation.

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Website: www.scme-nm.org

Learning Module Map for Etch Overview for Microsystems

This Learning Module introduces the most common etch processes used in the fabrication of microsystems. Activities allow students to demonstrate their understanding of the terminology and basic concepts of these processes.

Learning Module units (6):

- Knowledge Probe (KP)
- Etch Overview for Microsystems Primary Knowledge (PK)
- Etch Terminology Activity
- Science of Thin Films Activity (SCME Kit Available through <http://scme-nm.org>)
- Bulk Micromachining: An Etch Process Activity (SCME Kit required <http://scme-nm.org>)
- Final Assessment

IMPORTANT STEPS	KEY POINTS	REASONS
<u>Pre-test (Knowledge Probe)</u>	Have the participants complete the Knowledge Probe in their booklet or online.	Determine the participants' current knowledge of etch processes prior to starting the learning module. Compare the outcome of the KP against the final assessment to determine the effectiveness of this learning module.
<u>Inquiry –</u> Ask “What is etch or etching? Provide some examples.”	It is something they are familiar with, especially in nature. Examples – natural arches, widening river banks, rotting pipe, erosion of any type, sandblasting, sculpturing.	You want the participants to realize that they already know what etch or etching is – it’s nothing new. This unit will show how etch is used to make microdevices.
<u>Unit Presentation:</u> Present the <u>Etch Overview for Microsystems PK</u>	Participants should read the PK. A PowerPoint presentation can be downloaded from scme-nm.org and presented to all participants.	An introduction into etch is needed to help participants better understand the etch process. This will lead to more effective learning in the related activities.

<p><u>Activity 1:</u> Complete the “Etch Terminology Activity”.</p>	<p>This is a crossword puzzle of etch terms and their meanings. This activity could be a homework or classroom assignment. If you have access to the online course, participants can input their answers online.</p>	<p>Provides participants with a review of the terminology associated with etch processes and equipment.</p>
<p><u>Activity 2: Science of Thin Films Activity</u></p> <p>This activity can be used as a “stand-alone” activity or as part of this Etch Learning Module. It has its own PowerPoint presentation and the introductory material needed to complete this activity. This activity introduces the concepts of etch, oxidation and light interference. <i>There is a SCME kit for this activity that can be ordered through http://scme-nm.org.</i></p>		
<p><u>Activity 2 Inquiry</u></p>	<p>Have the participants look at the Rainbow Wafer (from the SCME kit) from different angles. What colors do they see? Do the colors of the layers change? When do they change? Why do they change? What are you seeing different colors?</p>	<p>This inquiry activity gets the participants curious about the wafers, the different colors they see, and how oxide thickness affects the colors on the wafer.</p>
<p><u>Activity 2 Introduction:</u> Introduce the “Science of Thin Films Activity” with its presentation.</p>	<p>The PowerPoint introduces the participants to three key concepts: etch rates, oxidation rates, and light interference. The presentation can be downloaded from http://scme-nm.org.</p>	<p>The presentation introduces the key concepts of the activity so that the participants gain a better understanding of the data and information gathered during this activity.</p>

<p><u>Activity 2:</u> Complete the “Science of Thin Films Activity”. (A kit is available through the SCME website (http://scme-nm.org) If you do not have a kit, participants can still complete this activity by using the photo of a rainbow wafer that is provided in the activity.</p>	<p>Correctly interpret oxidation charts.</p> <p>Estimate oxide thicknesses and complete <u>Rainbow Wafer Calculations Worksheet</u>.</p> <p>Calculate and graph etch rates and etch rates vs. oxide thickness.</p> <p>Explain several key concepts, such as <i>why are several colors seen in oxide thicknesses when oxide is transparent? Why is wet oxidation faster than dry oxidation? What is oxidation? What is etch rate and how can it be controlled?</i></p>	<p>This activity helps participants to develop skills for interpreting and developing graphs and tables.</p> <p>Participants learn the relationships between</p> <ul style="list-style-type: none"> • time and oxide thickness in oxidation processes, • oxide thickness and etch rates, • and oxide thickness and color. <p>They also learn how</p> <ul style="list-style-type: none"> • light interference affects what color they see on an oxidized wafer, • wafers are oxidized, and how • wafers are etched.
<p><u>Activity 3:</u> Complete the “Bulk Micromachining: An Etch Process Activity”.</p> <p><i>There is a SCME kit for this activity that can be ordered through scme-nm.org.</i></p>	<p>This activity uses hazardous chemicals and requires a fume hood for ventilation.</p> <p>Participants and instructors are required to wear the proper personal protective equipment.</p> <p>Participants observe the anisotropic etch of silicon using sodium hydroxide (Drain Cleaner).</p>	<p>This activity requires the mixing of sodium hydroxide and water.</p> <p>This activity provides participants with demonstration of bulk etch through the anisotropic etching of silicon on the backside of a MEMS pressure sensor die.</p>
<p><u>Assessment:</u> Complete the Etch Overview Assessment.</p>	<p>Give the participants the final assessment.</p>	<p>Compare the results of this assessment with the results of the KP to determine the effectiveness of this learning module in teaching the etch process.</p>

Adapted from Graupp, P. & Wrona, R. (2006) The TWI Workbook: Essential Skills for Supervisors. New York, NY. Productivity Press.

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>).