
Etch Terminology Activity

Etch Overview for Microsystems Learning Module

Instructor Guide

Notes to Instructor

This activity provides the participants an opportunity to better understand the terminology associated with Etch processing. Participants should read the PK unit before doing this activity in order to get an understanding of Etch terminology.

The *Etch Overview for Microsystems Learning Module* consists of the following:

- Knowledge Probe (KP) or pre-test
- Etch Overview for Microsystems PK
- **Etch Terminology Activity**
- Science of Thin Films Activity (SCME Kit available @ <http://scme-nm.org>)
- Bulk Micromachining: An Etch Process Activity (SCME Kit available @ <http://scme-nm.org>)
- Final Assessment

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 demonstrate your knowledge of etch for microsystems terminology. This activity consists of two parts:

- A **crossword puzzle** that tests your knowledge of the terminology and acronyms associated with etch processing, and
- **Post-activity questions** that ask you to demonstrate a better understanding of etch and its application to MEMS fabrication.

If you have not reviewed the unit *Etch Overview for Microsystems*, you should do so before completing this activity.

Estimated Time to Complete

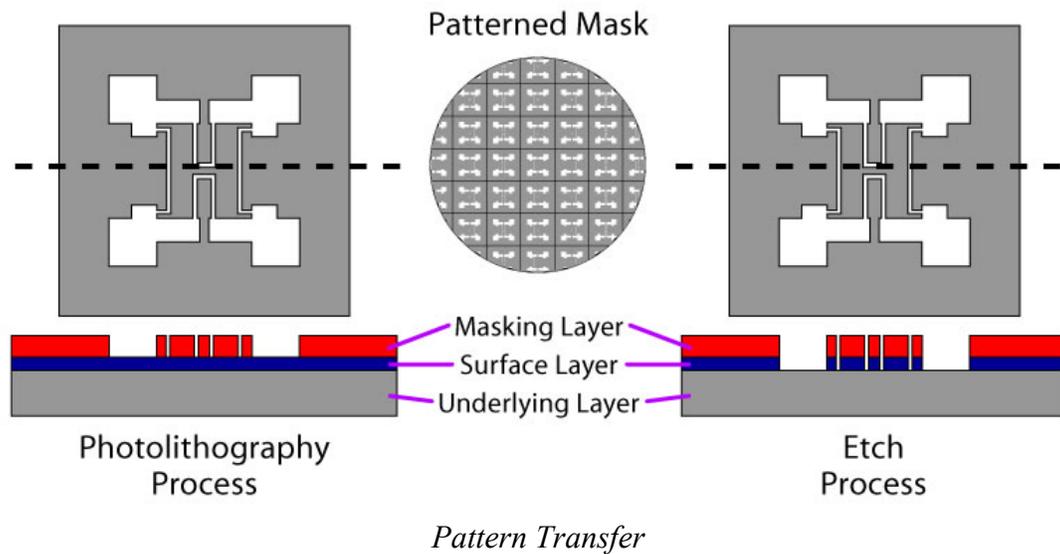
Allow at least 30 minutes to complete this activity.

Introduction

For microsystems fabrication etch is a process that removes select materials from

- the wafer's surface,
- below the wafer's surface, or
- from within the substrate.

The etch process normally follows photolithography or deposition during which a protective mask or layer is applied to the wafer's surface. The protective mask is to identify the material to be etched and to protect material that is to remain. The graphic (Pattern Transfer) illustrates a patterned mask incorporated into a photosensitive layer (or protective mask) on the wafer's surface (Photolithography Process). During the Etch Process (right), that pattern is transferred into the surface layer, exposing areas of the underlying layer.



Activity Objective

Activity Objectives

- Identify the correct terms used for several definitions or statements related to etch.
- Describe the etch process as it applies to microsystems fabrication.

Resources

SCME's *Etch Overview for Microsystems PK*

Documentation

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

Activity: Etch Terminology

Answer Key to Crossword Puzzle – Etch Terminology



EclipseCrossword.com

ACROSS

- The ratio of the etch rate of material to be etched divided by etch rate of masking material.
- Second step of the wet etch process.
- Type of films used for conductive layers.
- An etch that frees a microsystem component from an underlying layer.
- An etch process that uses a high energy plasma
- The layer that is completely removed to allow mechanical devices to move.
- The mask _____ layer determines the endpoint of the etch.
- The microsystems fabrication process that removes material from a wafer chemically and/or physically.
- Straight wall geometries result from this type of etch.
- A layer that defines the pattern to be etched.
- A type of dry etch process that uses a focused beam of ions to physically etch select material on the wafer.

DOWN

- Quick-dump-rinse.
- Type of etch that removes select material through a chemical reaction.
- The ratio of the height of an etched feature divided by its width (2 words)
- The type of etch process that uses liquid etchants.
- An active chemical solution or mixture used to etch films.
- Angstroms of film removed divided by time (2 words).
- A layer having the mechanical and electrical properties needed for a MEMS component.
- Etch process that creates high aspect ratio holes and trenches.
- Also called substrate etching (2 words).
- The type of etch profile that results from a chemical etch.
- A type of etch where ions bombard the surface of the wafer causing a sputter of surface material.
- An ionized and energized gas consisting of ions, electrons, and radicals.
- A process that uses a low pressure plasma allowing for a combination of both chemical and physical etching.

Answers

Selectivity

Rinse

Metals

Release

Dry

Sacrificial

Stop

Etch

Anisotropic

Mask

Milling

QDR

Chemical

Aspect ratio

Wet

Etchant

Etch rate

Structural

DRIE

Bulk etch

Isotropic

Physical

Plasma

RIE

Post-Activity Questions / Answers

1. The etch process can be performed several times during the fabrication of a microsystem; however, the purpose of the etch as well as the type etch process can be different. Describe the purpose(s) and applications of surface etch and bulk/release etch in the fabrication of microsystems.

Answer:

Surface Etch: The purpose of surface etch is to transfer the pattern on a masking layer into the surface layer below. A surface etch will bore through selected regions in the surface layer to expose an underlying layer of a different material. Surface etching is used to pattern microsystem components such as cantilevers, mirrors and probes, and to expose conductive interconnects.

Bulk/Release Etch: Bulk etching or bulk micromachining is when a bulk of material is removed from the wafer's surface (a sacrificial layer) or from the substrate material. The purpose of removing a sacrificial layer is to "release" a microsystems component in order for it to "move". This process is used for gears, combdrives, springs or any device that needs to move up and down, side-to-side, rotate, vibrate, bend or flex. Bulk etch removes substrate material in order to provide a "void" underneath a structural object such as a diaphragm or electrode.

2. Discuss the differences between a chemical etch and a physical etch.

Answer:

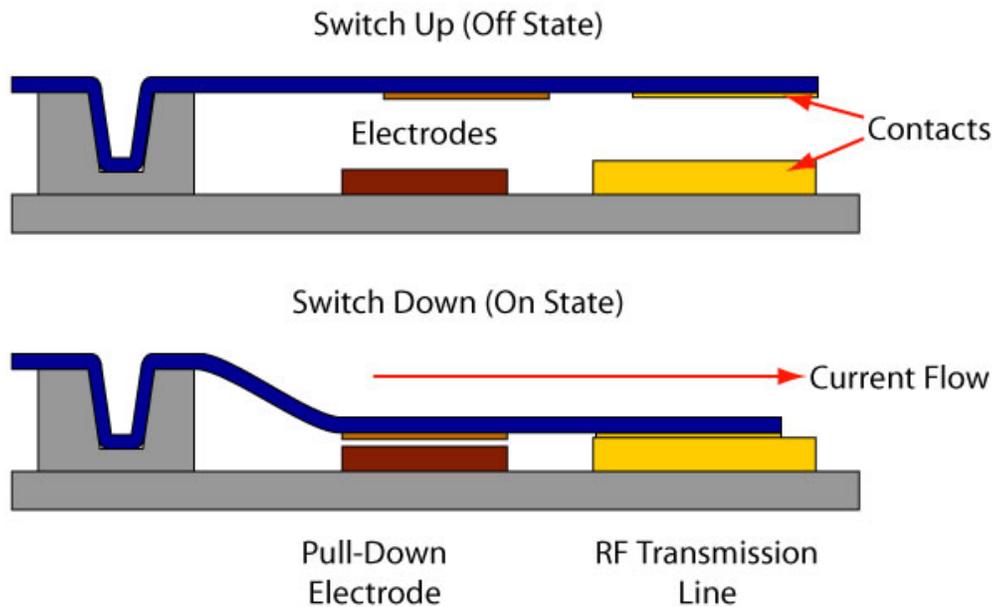
Chemical etch:

- A chemical etch is when select material from a surface layer or from the substrate is removed through a chemical reaction between the material to be removed and a liquid etchant or reactive particle such as a radical.
- A wet etch is always a chemical etch; however, a dry etch, specifically a RIE, can be both chemical and physical.
- A chemical etch is highly selective.

Physical Etch:

- A physical etch is when high energy positive ions bombard the surface of the wafer causing molecules to sputter off the surface.
- A dry etch is required for physical etching.
- A physical etch has poor or low selectivity.
- It is a physical process with no chemical reaction occurring.

3. Discuss the etch requirements (types of etch processes and etched layers) required for the RF switch shown in the graphic below.



Answer: This device would require several layers: anchor, pull-down electrode, contact, sacrificial layer, another electrode layer, another contact layer, structural layer (cantilever). With the exception of the sacrificial layer, all etch processes would probably be dry etch processes. The sacrificial layer between the electrodes and under the cantilever would be a chemical or wet etch.

Summary

In microsystems fabrication, etch processes are used to remove bulk material from within a substrate, select material from within thin film layers, and complete layers above and below other thin film layers.

Several different types of etch processes are required to form the various shapes and structures found in microsystems. Such process include

- Wet etch (isotropic and anisotropic)
- Dry etch (physical, chemical, and both)

RIE and DRIE are dry etch processes that use both chemical and physical etch to form the required shapes. DRIE provides the high aspect ratio cavities required for the advancing technologies of micro and nanosystems.

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