Semiconductor Technology from A to Z

Wet Chemistry

Etch processes

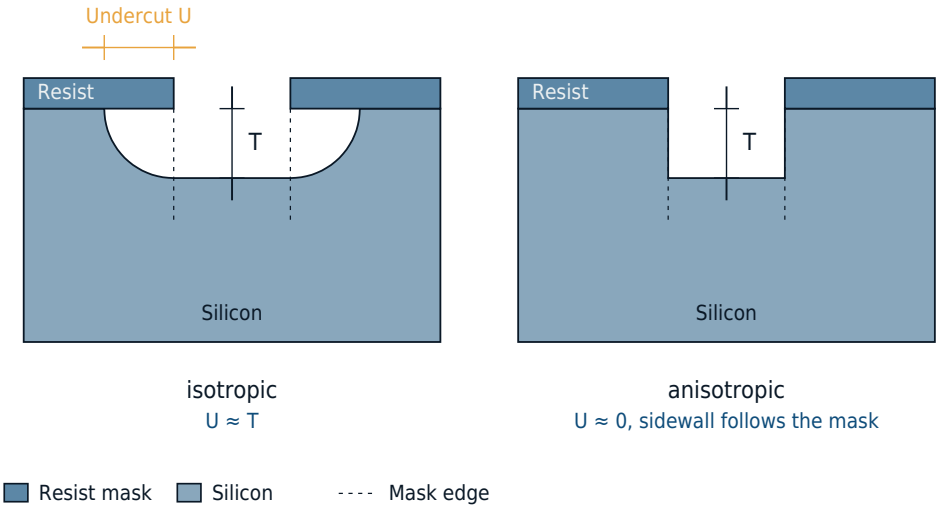
Overview

In semiconductor manufacturing, a wide variety of layers have to be etched. This may be either to remove a layer over the full wafer area, or to transfer a patterned photoresist film into an underlying layer. Etch technology can be divided into wet chemical etching and dry etching. In addition, a distinction is made between isotropic and anisotropic processes, as well as between the chemical and physical character of the etch process.

In an isotropic etch process, etching occurs in all directions. This means layers are removed not only in thickness but also in their lateral extent. In anisotropic etching, the layer is removed in only one direction. Depending on the process, either an isotropic or an anisotropic etch process may be desired.

Isotropic and Anisotropic Etching

With ideal isotropy, the undercut is about as large as the etch depth



Wet chemical etching mostly attacks without direction: the solution reaches the area under the mask just as it reaches the trench bottom – the structure becomes wider than the mask opening as a result. Anisotropic processes like RIE etch directionally instead, transferring the mask geometry almost unchanged.

An important parameter of etch processes is the selectivity. This indicates the removal ratio between two layers. If the selectivity is 2:1, one layer is removed by the etch process twice as fast as the other.

The wet chemistry described below, however, is not used solely for etching layers, but is also employed in other processes:

- Wet etching: for the full-area removal of doped and undoped oxide layers
- Wafer cleaning
- Resist removal
- Backside processing: removal of layers that formed on the wafer backside during furnace processes
- Polymer removal: removal of byproducts that form during plasma etching and deposit on the wafers
- Edge bevel removal: targeted removal of layers at the very edge of the wafer, where they would later flake off and generate particles

Because of its generally isotropic etch profile, wet etching is hardly ever used for patterning. An exception is micromechanics. Owing to the lattice structure of single-crystal silicon, wet chemical etch solutions can produce well-defined structures, such as those with sidewall angles of 90° or 54.74°.

However, the loss of its patterning role does not mean that wet chemistry has become less important – quite the opposite. The smaller the structures have become, the more process steps have been added, and the more sensitive the device has become to contamination. A modern process flow contains more wet chemical steps than ever before; it is just that these are now predominantly cleaning, removal, and pre-treatment steps rather than patterning steps. At the same time, the equipment technology has shifted from batch processing to single-wafer processing.