Brewer Science® MEMS Technologies

Solutions for MEMS, Sensor, & Display Applications

Brewer Science develops and manufactures a broad range of organic materials and provides process integration that enables the fabrication of MEMS devices.

Key Application Areas:

- Surface Energy Modification
- Micromachining
- Leveling Extreme Topography
- Thin Wafer Handling

Surface Energy Modification

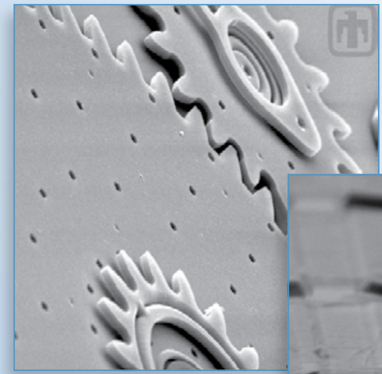
In constructing many of today's MEMS devices, it is necessary to modify the surface of the substrate to improve adhesion of additional coatings or to prevent substances from attaching to the substrate.

Brewer Science offers coatings that change the surface energy of the substrate to enhance the desired surface properties. The coatings can provide high, medium, or low surface energies to attract or repel other chemistries. We provide spin-on coatings that produce films nanometers thick, offer high surface energy, and attract similar high-surface-energy coatings.

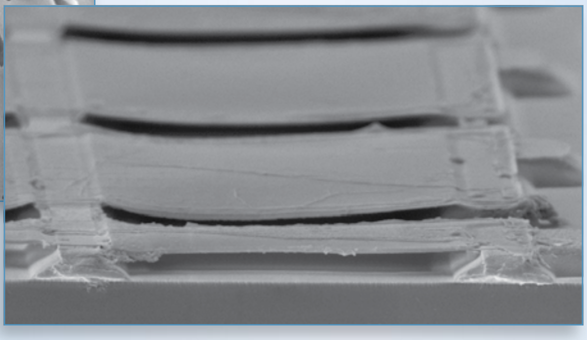
Brewer Science® low surface energy coatings repel water, inks, and other materials. These coatings come in versions that produce films with a range of thicknesses, from monolayers that are a few nanometers thick to films that are microns in thickness.

Where innovation takes flight!℠

Micromachining



Transmission for a microengine
Courtesy of Sandia National Laboratories, SUMMiT™ Technologies, www.mems.sandia.gov



Suspended IR bolometer created with Brewer Science technologies

Micromachining is divided into two categories: **surface** and **bulk**. In surface micro-machining, layers are added to the substrate and are patterned to create structures. Bulk micromachining uses various techniques to remove pieces of the substrate to create a pattern in the substrate. Most MEMS devices are created using both types of micromachining.

Buik Micromachining

Bulk micromachining is a process of removing pieces of the substrate. This process can be done using a wet process (alkaline or acidic etching) or it can be done using gas particles to "sandblast" the surface (deep reactive ion etching, DRIE). In wet processes, areas of the wafer are masked to prevent the etchants from reaching the surface. These areas will remain intact after the wet etch. Typical masking materials are inorganic films or spin-applied organics. The inorganic films, such as silicon nitride or silicon oxide, are chemically vapor deposited.

Organic films, such as Brewer Science® ProTEK® coatings, are spin-applied. These films can be used as either blanket coatings to protect one side of the wafer or are exposed to UV light to pattern them.

PRODUCTS:
ProTEK® B coatings for alkaline etching
ProTEK® A coatings for acid etching
ProTEK® SR coating for dry etching

Surface Micromachining

Surface micromachining entails growing, depositing, or coating thin films on a substrate and then patterning the films with a dry or wet etching process. Surface micromachining provides finer, more detailed structures in comparison to bulk micromachining.

To enable high-quality surface micromachining, Brewer Science offers anti-reflective coatings, sacrificial layers, planarizing coatings, and optical coatings.

Brewer Science® anti-reflective coatings improve the photolithographic process, enabling fine resolution of photoresist features.

Brewer Science® sacrificial layer materials allow the patterned deposition of metals, oxides, and inorganics. Typically the sacrificial layer is placed under a photoresist so that the photoresist can be removed after deposition.

As structures on the substrate become more three-dimensional (3-D), photoresist uniformity over the structures becomes more difficult. Brewer Science® leveling materials fill in the structures to create a flat surface for the photoresist. Once the photoresist has accomplished its task, it and the leveling material are normally removed.

Brewer Science® optical coatings provide transparent films that are spin-applied and offer either high or low refractive indices.

PRODUCTS:
ARC® bottom anti-reflective coatings
Planarizing materials

Leveling Extreme Topography

Dry Etch Back

The dry-etch method of planarizing is straightforward. Typically, an organic film is coated on the wafer. This material must have self-leveling properties to minimize the difference in overburden between areas with high feature density and areas with low feature density. Overburden is the thickness of material extending beyond the top of the trenches, and "self-leveling" refers to the tendency of the material to flow or reflow during processing to create a uniform flat surface across the wafer. Once the material is coated and baked, the wafer is placed in a dry-etch chamber and is oxygen-ashed to remove the overburden.

The advantage of this method is that a wide range of materials can be used. Depending on the material selected, methods for removing the fill include dry etching, wet etching (with solvent or developer), or thermal decomposition.

The disadvantage of dry etching is that it does require a dry-etch tool. Also, during the dry-etch-back process, other organic films on the substrate could be damaged.

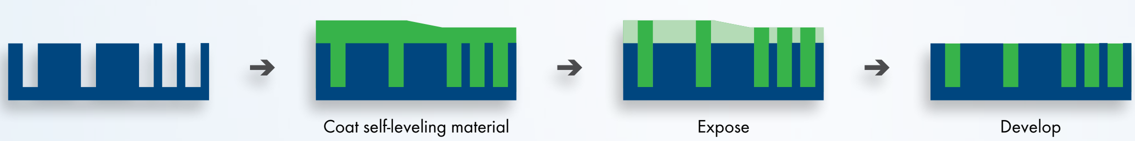
Wet Develop Back

The wet-develop method is similar to the dry-etch-back process except that either TMAH developer or a solvent is used to remove the overburden. The etch rate for many of our materials is much faster for the overburden than the etch rate in the vias or trenches. This characteristic reduces the iso-dense variance.

An advantage of the wet-develop method is that all the processing can be performed on a standard lithography track. Also, the film can be removed later by the same wet processing. The disadvantage is that the the film's ability to be removed in developer or solvent may limit downstream processing. In some cases, the material can be cured after developing so that it is no longer soluble. However, curing limits the removal method to dry etch only.

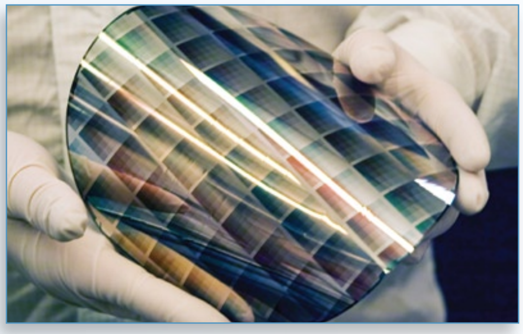
Expose and Develop

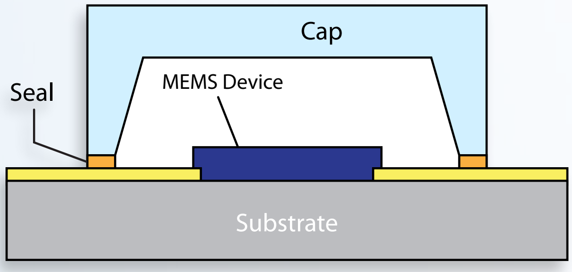
The last method for leveling topography is expose and develop. In this method, a photosensitive material that has self-leveling properties is used. The material is coated on the wafer and baked. The wafer is then exposed by photolithography (the material is typically negative acting) to set the material in the vias or trenches. The overburden in the open areas is removed by either a TMAH developer or a solvent developer, depending on the planarizing material being used. After exposure, the material in the vias is normally removed by plasma etching.



Thin Wafer Handling

Temporary Bonding Technologies





Wafer-level packaging (WLP) is commonly used for packaging of MEMS and LED devices as it offers advantages in cost, yield, and reliability. In a WLP scheme, MEMS structures or LED die are encapsulated between bonded wafers, one of which has cavities that are fabricated most commonly by bulk micromachining.

The thinned silicon wafers are fragile and require a temporary rigid support that allows the wafer to be successfully processed for stacking. When finished, the thin processed wafer must be separated from the rigid support using a simple, cost-effective process, without resulting in damage.

The bonding materials used to attach the device wafer to the rigid support, or carrier, must meet very stringent requirements. They must survive extreme temperatures, harsh corrosive and solvent chemistries, and mechanical stresses created by thermal excursions. They must permit separation (debonding) of the very delicate wafer from the rigid carrier, and leave no residue after debonding and cleaning.

PRODUCTS:
WaferBOND® temporary bonding materials
ZoneBOND™ low-stress debonding process
Cee® 1300DB thermal slide debonder
ZoneBOND™ separation tool