

Anisotropic Silicon Etch Using KOH

INRF application note

Process name: KOH01

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Overview

KOH is a wet etch which attacks silicon preferentially in the 100 plane, producing a characteristic anisotropic V-etch, with sidewalls that form a 54.7° angle with the surface (35.3° from the normal).

Time needed

The KOH process takes typically 1 hour for a $40\ \mu\text{m}$ etch: 20 minute prep time followed by 40 minutes etch. Lithography and reactive ion etch take additional time.

Materials needed

- 100 silicon wafers with thermally grown oxide or nitride layer ($\sim 2000\text{--}3000\ \text{\AA}$)
- KOH pellets (available from chem stores)
- Glass container
- Thermometer
- Hot plate

Preparation

Wear protective nitrile gloves and eye protection. Prepare a fresh KOH solution in the following manner. Weigh 1 part KOH pellets (by weight) into a plastic beaker. Add 2 parts DI water. For example, use 100 g KOH with 200 ml water. Mix on warm surface until KOH has dissolved. Add ~ 1 ml of isopropyl alcohol to the solution. The isopropyl alcohol lowers the surface tension of the solution which results in smooth etching. Store in plastic bottle labeled "30% KOH solution", then add your name, the date, and a target organs sticker.

KOH recipe (30%)

- 100 g KOH pellets
- 200 ml DI water
- Mix on warm surface until KOH has completely dissolved.
- Add 1% (by volume) isopropyl alcohol

The KOH etch requires a "hard mask" of silicon dioxide or silicon nitride. The details on making a hard mask can be found in other documents. The basic approach is as follows. Start with silicon 1-0-0 polished wafers. Clean wafers¹ and pattern with photoresist². Use the reactive ion etch (RIE) system to etch the exposed oxide or nitride surface³. For oxides, the recommended chemistry is CHF_3 and O_2 or CF_4 and O_2 . Etch until the silicon is exposed (shiny); typically 5 minutes per $1000\ \text{\AA}$ film.

Rinse the wafer with acetone to remove the remaining photoresist. Rinse with DI water, then blow dry.

¹ See the INRF application note, "Cleaning procedure for silicon wafers (WAFERCLEAN)".

² See the INRF application note, "Spinning photoresist on substrates (LITHPREP1813)".

³ See the INRF application notes and user's manual regarding the reactive ion etch system.

Procedure

Put KOH solution in glass container and warm to 80° C on a hot plate. If desired, use a mixer to agitate the solution. Place patterned wafer (with patterned hard mask) in the KOH solution. The KOH will bubble at the exposed silicon sites while etching occurs. The etch rate for 30% KOH at 80° C is ~1 micron/minute.

For smoother walls and surfaces, adjust the amount of isopropyl alcohol in the etch bath (typically 1% by volume). This lowers the surface tension of the solution and usually results in smoother walls.

Clean up

Pour used KOH solution in the appropriately labeled waste container.

References

KOH anisotropic silicon etch Checklist

The following checklist is designed to aid the researcher when performing this process.

- Substrate must be clean with hard nitride or oxide mask. No photoresist.
- Prepare KOH solution: 30% KOH by weight. 1% isopropyl alcohol.
- Heat to 80 °C on hot plate. Stirrer may also be used.
- Soak wafer in etchant. Don't cover.
- Etch rate is about 1 micron/minute.
- Remove early, DI rinse / blow dry. Check on profilometer.
- Clean up, dispose wastes.