

Iron Oxide Masks

INRF application note
Process name: IRONMASK

Overview

Iron oxide masks (“Ferroxoplate”) are used for making contact exposures on substrates. The iron oxide plates can be patterned at high resolution, are durable, and are transparent to visible light, yet opaque to ultraviolet light. According to the manufacturer (Towne Technologies, Inc.) the semi-transparent coating is the hardest available to the photo mask maker. The physical characteristics and economy of the Ferroxoplate makes it a replacement for emulsion and chrome photo masks in contact or projection wafer printing. The coating is extremely abrasion resistant iron oxide; they are ideal for long term masks.

The iron oxide plates are made from drawn soda lime glass, 0.060 inch thick, polished on both sides, with flatness of better than 150 micro inches per linear inch. The coating is iron oxide 3100 Å +/- 5% in thickness. They come pre-coated with Shipley positive photo resist (1800 series), spun onto 5000 Å thickness.

This is a level-2 process; it requires super user instruction. The use of flammable and corrosive chemicals requires that this process may not be performed alone.

Time needed

The process takes typically 1 hour and 30 minutes per batch of iron oxide plates.

Materials needed

- High resolution iron oxide mask plates (Towne Technologies, Inc.)
- Original high resolution mask
- Pyrex bath containers
- MF-319 developer (TMAH) or MF-351 (NaOH)
- Ferrous chloride etchant: ferrous chloride crystals, hydrochloric acid

Preparation

Prepare ferrous chloride etchant by mixing the following chemicals.

- 160 g ferrous chloride crystals (FeCl_3)
- 350 g water
- 700 g concentrated hydrochloric acid (HCl)

Dissolve the ferrous chloride crystals in water at 40 deg C. Add the hydrochloric acid to the solution. Allow solution to return to room temperature.

It is recommended that the plates be pre-baked before use. Bake at 100 deg C for 30 minutes.

Procedure

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Place original mask in the Karl Suss MJB3 or other aligner. Place iron oxide plate on substrate tray, bring into contact with original mask then, expose to UV for approximately 30 seconds (1).

After developing, place in MF-319 developer (TMAH) or MF-351 (NaOH) for 45 seconds. Rinse with DI water then, blow dry.

Place masks in ferrous chloride etchant. Allow masks to etch for 40-60 seconds, or longer, depending on the condition of the etchant. The best way to determine when the plates are finished is to rinse them in DI water and inspect them. The etched areas should be totally transparent (clear as glass). If not, the etching process is not complete. You do not have to worry much about over-etching. The undercut from over-etching will not be more than the metal thickness, 0.3 microns.

When the etch process is complete, rinse plates with DI water and blow dry. Inspect images. If images are good quality, proceed to strip resist layer. Remove the resist by soaking in warm (40 deg C) acetone for 5-10 minutes, followed by an alcohol rinse. Rinse in DI water then, blow dry. After cleaning, inspect mask for imperfections under microscope.

After mask has been cleaned, place in 120 deg C oven for 45 minutes to enhance film hardness.

Clean up

Place unused developer, acetone and alcohol in appropriately labeled waste containers. If etchant is not too old, it may be recycled. Clean up work area and put away all supplies.

Safety and emergency

All INRF safety and procedural regulations must be followed. Review the INRF Standard Operating Procedures for fire, chemical spill and chemical exposure. Use of etchants requires at least one other person in the clean room (buddy system). Etching and development should be performed in a laminar flow bench, using nitrile gloves and eye protection.

(1)

Exposure times may vary depending on the condition of the lamp. Check with other users or the INRF staff to estimate the current status, or measure the power directly using a power monitor (available from the INRF staff).

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Never leave the heated solvents unattended. Do not store the unused acetone near the hotplate or any other source of heat. Keep the acetone away from the etchants. Any small spills should be wiped up immediately with wipes. Dispose of the wipes in the corrosive or flammable waste container.

In case of exposure to skin or eyes flush immediately with water for 15 minutes. Remove all clothing that are exposed and flush with water. Report to INRF staff or report to EH&S. Seek medical attention to ensure that the burns are minimal.

In case of large spill, follow INRF Standard Operating Procedure for chemical spills.

References

Towne Technologies Process Procedures, www.townetech.com/feo-proc.htm.

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Checklist

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

Prepare ferrous chloride etch solution:

160 g ferrous chloride

350 ml water

700 ml HCl

Pre-bake plates at 100 deg C for approximately 30 minutes

Expose UV to mask for 30 seconds. Develop 45 seconds in MF-319 or MF-351 developer. DI rinse.

Etch in ferrous chloride etch solution for 45-60 seconds or until completed. DI rinse.

Inspect mask

Remove resist in acetone for 5-10 minutes, rinse with isopropyl alcohol. DI rinse

Post-bake in 120 deg C oven for 45 minutes

Dispose old developer in disposal bottles. If etchant is not too old, it may be re-used. Clean up.