TMAH-KOHhood

STANDARD OPERATING PROCEDURE

CORAL Name: *TMAH-KOHhood*

Model Number: --

Location: EML (physically; this is an ICL machine)

What it does: hood

Introduction: This machine is for TMAH and KOH etching of wafers that are clean enough to meet MTL's CMOS or Au standards. This is an ICL hood located in the 5th floor EML metrology room.

To some extent, Tetramethylammonium hydroxide (TMAH) and to a much greater extent Potassium hydroxide (KOH) are anisotropic etches, meaning they etch different Si crystal planes at different rates, make sure you know your wafer crystal orientations and etch rates.

TMAH will etch Si at a rate of about 20u/hr for 25wt% (in water, bought premixed) at 80C in the slightly preferential (100) direction. The addition of isopropanol (IPA) can decrease the undercut of the mask, and increases selectivity on pp+. Masks can be oxide, nitride, or in some cases, aluminum, but a pre-condition to processing here is wafers must meet the TRL green or red contamination levels. Resist is not allowed either.

(KOH) will etch Si in the (100) direction much more rapidly than other planes. With a 54.7deg angle to the (100) etch, a 100u wide circular surface feature would etch rapidly to a depth of 70.6u, in an inverted pyramid shape, then slow when only the (111) etch is left. Observed etch rates are 80u/hr in (100) and less than 10u/hr in (111), when mixed 25wt% in DI, at 80C, with 3 drops/liter of FC-129 surfactant. IPA has been used to improve selectivity to the (100) plane and decrease the etch rate of p+ doped Si. Masks are usually nitride, although there is a moderately slow oxide etch rate. Wafers to be processed here must meet the TRL yellow-dot contamination level, w/o Au or III-V contamination.

Wafers to be TMAH etched should be free from native oxide if possible: consider an HF dip immediately prior to Using this equipment, as the selectivity to oxides is great and surface roughness will be imparted by the oxide non-uniformity.

Wafers which have seen implant and thermal cycle damaging events will display rough surfaces, otherwise the surface will be exceptionally smooth.

Safety: Chemicals used in the TMAH-KOHhood are corrosive and toxic, and care must be taken in handling them. Besides the smock, hood, booties and vinyl gloves, which must be worn at all times in EML, you must also wear the face shield, latex gloves, vinyl sleeve protectors and splash apron, when Using the hood. Know the location of the eye wash and safety shower, and become familiar with the MSDS for any chemical you use. Do not add KOH to water heated up much past 60C, as the dissolving is exothermic, and will cause a vigorous instantaneous and dangerous boiling over situation

Procedure:

1. Reserve the machine under CORAL, for 2 hrs plus 1 hr for every 75 µm to be etched for KOH, or 2 hr plus 1 hr for every 20 um to be etched for TMAH.
2. Engage in CORAL when starting.

   NOTE: Contamination control is of the utmost importance. Make sure you are Using the correct KOH or TMAH labware, that it is clean and stored correctly at the beginning and end of your

process. Be especially diligent in making sure NO inadvertent use of EML labware or tools is made, as EML processes are expressly forbidden from entering ICL or TRL, ever. Also, make sure you use only DI water: never, for any reason, use city water when processing in this hood. DI water is from the plastic spigots or spray guns, city water from the metal (chromed or copper) faucets. Items compatible with KOH etching will be marked in yellow, and TMAH items will be marked in green, in the convention of the TRL. After Using any item, rinse it three times with DI water, and let it dry on fabwipes or N2 blow-dry it before putting away. Any process surface, such as wafer carriers, thermometers, or tweezers must not be allowed to touch any counter surface, but need be rested on clean fabwipes instead.

3. Close drain spigot on the circulated hot water bath, fill with DI water at least ½ full, plug in to a ground fault interrupter outlet, and press up or down arrow to reach desired temperature setpoint, then press the left button, "enter". Leave plastic evaporator balls in the water, and the wire rack to keep the beaker off the bottom of the water bath.
4. Materials needed are located under the hood, with TMAH items on the left, and KOH items on the right. Please do NOT mix them; they are incompatible as TMAH is a cleaner process than KOH, and the combination of flammable organics like TMAH with an ionic base like KOH is dangerous.
    a. KOH:
        - EQUIPMENT: Under the right side of the hood, find dry KOH pellets, FC-129 surfactant, stainless beaker w/lid, and a two-liter graduated cylinder for measuring DI water. In the "KOH Only" drawer, to the right of the hood, find a 500ml plastic beaker, a single wafer carrier for mixing the KOH in the DI, tweezers marked KOH, and disposable pipettes.
        - PREPARATION: Measure your target quantity of DI, for instance 3 liters, into the quartz tank. Heat the quartz tank in the water bath up to a temperature of between 40 and 60 C, approximately, then weigh your KOH, Using 250g/l to get a 20% concentration by weight (250/1250=.20). Slowly pour the KOH pellets into the warm water, stirring constantly with either the Teflon rod or a thermometer. **Caution: Do not pour pellets into HOT water, as this is an exothermic reaction, and the KOH solution will immediately and violently boil over!!** Put the polypropylene lid on the tank, and the clear lid on the water bath, to limit evaporation and allow temperature stabilization, for an hour before processing.
        - ETCHING: Check the temperature of the KOH solution with a thermometer from the KOH drawer, and if correct, put your wafers into the yellow-dot KOH 25 wafer teflon cassette with the cassette handle, etch side up, in the KOH solution. When etch done, before the wafers are removed from the solution, you will need to fill up the rinse tank from the KOH cabinet with DI water. Remove the wafers from the KOH solution (let condensed water on lid drain back into KOH solution) and rinse for 5 – 10 minutes. Return lid on bath, and turn off power. Dry wafers and inspect results, being sure to put a clean fabwipe or slide under wafers when being inspected at microscopes. If wafers need further etching, and if there are small, deep well-etched patterns in the wafer, you will need to make sure these small areas re-wet before re-immersion into the KOH solution. This can be done by tapping the KOH bath to free the bubbles from the wells, or by Using the spray DI at a shallow angle to force water into the wells, then inserting into the KOH w/o tilting and draining them.
        - ENDING: When etching is done and inspection completed, rinse and dry wafers. Then turn off the water bath and open the water bath drain into the sink. Aspirate out the KOH solution and rinse the quartz tank well, at least three times. Evaporator balls may be left in place, and rinse the interior of the bath and the lid with DI. Rinse all labware, baths, lids, wafer carriers and counter surfaces with DI, dry, and put away before you leave the room. Rinse gloves and de-gown last.
        - POST-KOH PROCESSING: Wafers that have been KOH-etched must go thru a standard post-KOH clean in TRL, which consists of a yellow-dot rinse in the sink, a yellow-dot piranha x 10min, yellow-dot rinse, green-dot piranha x 10min, dump-rinse, green-dot 50:1 HF dip x 30sec, dump-rinse. The wafer box or single wafer carrier you carried the wafer in must be labeled "KOH" or must be yellow-tagged:

these items can not be post-KOH cleaned, and any wafers which ever go into these carriers will immediately be considered KOH contaminated.

b. TMAH:
   - EQUIPMENT: Under left side of the hood, find premixed 25%wt TMAH and a green-dot quartz tank with a polyproplyene lid. In the “TMAH Only” drawer, to the right of the hood, find measuring beakers, a 25 wafer cassette, and tweezers marked TMAH.
   - PREPARATION: Pour undiluted TMAH into the beaker, put the lid on this beaker, and put it in the DI water bath. Put the clear plastic lid on the water bath, and allow temperature to stabilize for an hour before processing.
   - ETCHING: Check the temperature of the TMAH with a thermometer from the TMAH drawer, and if correct, put your wafers into the green-dot TMAH 25 wafer teflon cassette with the cassette handle, etch side up, in the TMAH. When etch done, before the wafers are removed from the solution, you will need to fill up the rinse tank from the TMAH cabinet with DI water. Remove the wafers from the TMAH solution (let condensed water on lid drain back into TMAH solution) and rinse for 5 – 10 minutes. Return all lids to tanks, turn off power to bath. Dry wafer and inspect results, being sure not to contaminate wafer at the EML microscope by use new slides and the TMAH tweezers.
   - ENDING: When etching is done and inspection is complete, turn off the water bath and open the drain into the sink, and aspirate the TMAH out. Evaporator balls may be left in place, and rinse the interior of the bath and the lid with DI. Rinse all labware, baths, lids, wafer carriers and counter surfaces with DI, dry, and put away before you leave the room. Rinse gloves and de-gown last.
   - POST-TMAH PROCESSING: Wafers which have been TMAH-etched need a piranha in green-dot labware before entering TRL or in blue-dot labware before entering ICL.

Disengage in CORAL.

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