

# Transetch N – Aluminum Etching Standard Operating Procedure

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## 1. Purpose and application

Transetch-N is a purified reagent, derived from ortho-phosphoric acid, which selectively etches deposited  $Si_3N_4$ , GaN and  $Al_2O_3$  films. When used as directed, it produces openings in these films with a degree of resolution comparable to the best obtainable with  $SiO_2$  in conventional planar technology, but with essentially no effect on exposed silicon or silicon dioxide surfaces. The photoresist materials, processes and equipment used in conventional etching operations are retained, and the additional equipment required is minimal and inexpensive. Note: Many photoresists may not be able to withstand the recommended operating temperature of Transetch N. **Consult with KN staff for more information about your resist before proceeding.** 

Transetch-N contains no fluorides. Unlike etchants based on fluoride chemistry, Transetch-N produces minimal undercutting and therefore provides a wide margin of safety in the selection of etching times.

The etchant is stable and long-lived. The only attention which it may require in use is the addition of small amounts of water to replace that lost through evaporation.

The etch rate of Transetch-N is 120 Å/min at a temperature of 178-180 °C [1].

## 2. Equipment, Chemicals and Supplies

Transetch-N is composed out of two chemicals:

- 1. 92 93 wt.% Phosphoric acid
- 2. 7 8 wt.% Water

Mixture is purchased from Chimie Tech Services. <u>https://www.chimietech.com/cms/index.php?option=com\_content&view=article&id=53&Itemi</u> <u>d=64&lang=en</u>

## 3. Personal Protective Equipment (PPE)

The following equipment should be used:

- Eye protection: Safety glasses (optional with face shield).
- Protective gloves: Black neoprene gloves. Check gloves for leaks before use.
- Protective clothing or equipment: Apron.



## 4. Operational Procedures

- 1. Get three glass beakers or envelopes which will fit your sample and place them in the bench.
- 2. Write down your name and type of chemical for every beaker/envelope.
- 3. Carefully pour some Aluminum Etchant type N in the first beaker/envelope such that it will cover your sample.
- 4. Fill the other two beaker/envelopes with DI water such that it will cover your sample. DI water is used for rinsing the etchant.
- 5. If you plan to heat the etch (recommended) set up an au bain-marie with a hotplate in the hood. Put the beaker/envelope filled with etchant in the au bain-marie (use a holder when you use an envelope) to bring it up to temperature. Use an temperature sensor housed within a glass enclosure to measure the temperature of the etchant. Direct heating of inorganic mixtures at temperatures higher than 80 °C is only allowed in day time and only after personal approval of the set-up by the KN staff.
- 6. Calculate the etch time for your sample. You will need to know the thickness of your aluminum layer. At 178-180 °C, the Al will etch at a rate of approximately 120 Å/min. This may not be exact and is highly susceptible to temperature! It is recommended to test this for yourself.
- 7. Put your sample into the etchant and move your sample for the appropriate amount of time calculated in the previous step. *If etchant at the surface becomes saturated and fresh etchant cannot reach the surface, then etching will slow down. Agitation can be used to bring etchant to the surface and promote etching.* In this case use a magnetic stirrer and carefully swirl your etchant to accelerate the etch and improve uniformity.

#### **DI Water rinse**

- 1. When the etch is complete, transfer the sample carefully to the first DI water rinse beaker/envelope and move the sample for 3 mins in DI water.
- 2. If you use tweezers to move the sample, make sure you rinse your tweezers as well.
- 3. Transfer the sample to the second DI rinse beaker, and rinse for another 3 mins while moving your sample.

#### Sample dry

1. After the water rinse is finished, remove your samples and blow them dry with the  $N_2$  gun.

#### Clean-up

- 1. Let the etchant cool down to room temperature.
- 2. When the used etchant is at room temperature, pour it carefully over the other two beakers/envelopes filled with DI water.
- 3. Fill the beaker/envelope where you had your etchant with DI water.
- 4. Use the venturi to remove the waste from all the beakers/envelopes.
- 5. Rinse all the beakers/envelopes three times with DI water.
- 6. Turn all the beakers/envelopes upside down, wash the outside with DI water and blow them dry with the  $N_2$  gun.



- 7. Return all labware to its proper location.
- 8. Clean the area and rinse it with DI water.
- 9. Wash your black gloves and leave them in the bench.

## 5. Primary Hazards

Corrosive. Vapour inhalation burns mucous membranes; causes coughing, dyspnoea. Inhalation may lead to oedemas in the respiratory tract. Burns skin, eyes (risk of blindness). Swallowing results in damage to mouth oesophagus, and gastrointestinal tract; risk of perforation; bloody vomiting. Keep away from combustible material.

## 6. Engineering Controls to Prevent and Mitigate Hazards

Carry out the procedure in a wet bench. Store bottles of chemicals (sealed tightly) in the inorganic cabinets. Work area should contain an eye wash, safety shower and a bottle of diphoterine. Check where you could find this in your neighbourhood.

The chemicals are in the medium risk category:

- Processing during afterhours requires the presence of a buddy, mixing of chemicals is not allowed (prepare your solution beforehand) and the maximum quantity of liquid is 100 ml.
- If one of these points is not fulfilled the process is considered to be high risk and it must be done during office hours.

## 7. First Aid and Emergency Procedures

<u>Eye Contact</u>: Immediately flush with diphoterine while lifting upper and lower eyelids occasionally (use the complete 500 ml for one eye and remove contact lenses if possible). After using diphoterine, flush with water for at least 15 minutes. Get immediate medical attention. Press the evacuation button.

<u>Skin Contact</u>: Remove contaminated clothing, wash skin with diphoterine for 15 minutes. After using diphoterine, flush with water for at least 15 minutes. If there is any irritation, get medical attention. Press the evacuation button.

<u>Inhalation</u>: Remove to fresh air. Resuscitate if necessary. Take care not to inhale any fumes released from the victim's lungs. The quick response team has to use the "Eerste Hulp Zuurstof Tas". Get immediate medical attention. Press the evacuation button.

<u>Ingestion</u>: May cause severe and permanent damage to the digestive tract. Causes gastrointestinal burns and perforation of the digestive tract. Get immediate medical attention. Press the evacuation button.

In case of a spill: Press the evacuation button.

In case of a fire: Press the fire button. Use the  $CO_2$  extinguisher to extinguish the fire. Do not use organic media.



## 8. Literature

- [1] "Transetch-N," 2018. [Online]. Available: http://transene.com/al2o3/. [Accessed 13 April 2018].
- [2] T. C. Inc., "Safety Data Sheet," April 2016. [Online]. Available: https://wcam.engr.wisc.edu/Public/Safety/SDS%20-%20GHS/SDS%20E-COPY/Transetch%20N.pdf. [Accessed 2018].

## 9. Appendix

Table 1 Etch rate of Transetch-N on metal at 178-180°C [1].

Metal	Etch rate
Aluminum oxide	120 Å/min
Silicon nitride	125 Å/min
Galium nitride	80 Å/min
Silicon dioxide	1 Å/min
Silicon	1 Å/min

Table 2 Properties of Tranetch N [2].

Appearance	Colorless
рН	<2
Boiling Point	>178-180 °C
Sp.Gr.@25°C	1.49
Flash Point	Non-flammable
Solubility	Miscible with H <sub>2</sub> O
Etch Rate at	
178-180°C	120 Å/sec