

# Listing of Chemistry

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## Some Important Information

- Listed below are chemicals that can be found in the SMFL that are available for use.
- There are chemicals in the cleanroom that do not belong to the SMFL. Permission from the owner is required before use. They will be marked with the owner's name.

⚠ If the chemical you need is not on this list, it must be signed off by the SMFL first before it comes into the facility!

- Please fill out the [SMFL Imported Chemical Form](#) first
  - See the [SMFL Imported Chemical policy](#) for more information.
  - **The SMFL maintains it's [SDS database](#) on this wiki.**
  - **This information is not intended to be the ultimate source for safety information, merely a starting point**
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## Lithographic Chemicals

### [CD 26 Developer](#)

- Used in the development of many photoresists. In the SMFL it is used primarily to develop the OiR 620M and HPR 504 positive photoresists.
- Based on Tetramethyl Ammonium Hydroxide or TMAH
- ⚠ [Please see the warnings on TMAH](#). It is toxic and there is no antidote.
- Tools
  - Used in [SVG Track #1](#)
  - Used in [SVG Track #2](#)
  - *Used in [CEE Resist Developer](#)*

### [HMDS](#)

- Hexamethyldisilazane
- **Poses a serious safety concern - toxic if inhaled.**
- HMDS is an organic, flammable solvent and is used to treat substrate surfaces prior to photoresist coating (primarily positive resist).
- When an organic photoresist with a high surface tension is coated over a hydrophilic, low surface tension surface (such as silicon dioxide), dewetting and adhesion problems can occur. Exposure of the low surface tension substrate surface with HMDS will chemically convert the surface to raise it's surface tension to match the organic photoresist.
- Over exposure to the HMDS can also result in adhesion problems.
- Tools
  - Used in [SVG Track #1](#)
  - Used in [SVG Track #2](#)
  - Used in [CEE Resist Coating Station](#)

### [LOR Liftoff Photoresist](#)

Material that is coated under photoresist to provide a undercut layer for liftoff processes. The S

- Tools
  - Used in [CEE Resist Spinner](#)
  - Used in [SCS Resist Coater](#)
- References
  - Manufactured by [Microchem](#)
  - [LOR Data Sheet](#)

### [MIR-701 Photoresist](#)

- General purpose high resolution resist - 14cPs viscosity
- Sensitive at 436nm and 365 nm
  - Tools
    - Used in [SVG Track #1](#)
    - Used in [SVG Track #2](#)
- References
  - [MiR 701 Series Data Sheet](#)

### [SU8](#)

- An epoxy based, chemically amplified, negative acting photoresist.
- The SMFL has some SU8 available - please check to see which formulations are on hand
- Cured films are highly resistant to solvents, acids and bases and have excellent thermal stability

- Well suited for permanent use applications.
  - Tools
    - Used in [SCS Resist Coater](#) **only**
  - References
    - [SU8 Datasheets at Microchem website](#)
    - [Good information at Memscyclopedia](#)
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## Acids

### Ammonium Fluoride

- **Poses a serious safety concern.** See the [SMFL Safety Information about Fluorine Poisoning Compounds](#)
- Used along with HF to form Buffered Oxide Etch solutions in the etching of silicon dioxide.
- Tools
  - Used in [BOE / HF Wetbench](#)
- References
  - [Wikipedia entry on Ammonium fluoride](#)

### Hydrochloric Acid

- SMFL incoming solution is 38%.
- Used in the RCA Clean process
- Used for decontamination clean after Potassium Hydroxide (KOH) etches.
- Tools
  - Used in [MOS RCA Bench](#)
  - Used in [General RCA Bench](#)
  - Used in [Manual Processing 2 Wetbench](#)
- References
  - [Wikipedia entry on HCl](#)

### Hydrofluoric Acid

- **Poses a serious safety concern.** See the [SMFL Safety Information about Fluorine Poisoning Compounds](#)
- Used primarily in the etching of silicon dioxide
- Comes in a variety of strengths.
  - Highest concentration in the SMFL is 49% - immediately dangerous - tightly controlled
- Can be used in dilute form during the RCA Clean for removal of the chemically grown native oxide.
- Tools
  - Used in [BOE / HF Wetbench](#)
  - Used in [MOS RCA Bench](#)
  - Used in [General RCA Bench](#)
  - Used in [Nitride & Silicon Etch Wetbench](#)
- References
  - [Wikipedia entry on HF](#)
  - [Medical Treatment Reference by Honeywell](#)
  - [Paper of Hydrofluoric Acid Poisonings](#)

### Nitric Acid

- **Use with caution! Very strong oxidizer, corrosive and toxic**
- Used in a variety of etchant mixtures. SMFL incoming solution is 70%
- Reacts strongly with flammables - keep away from solvents.
- References
  - [Wikipedia Entry on Nitric Acid](#)

### Phosphoric Acid

- Basic component of Aluminum etchants.
- SMFL incoming solution is 85%.
- Used for other etching & etchant mixtures. Hot phosphoric acid is used for silicon nitride etching.
- Tools
  - Used in [Al Etch & Solvent Strip Wetbench](#)
  - Used in [Nitride & Silicon Etch Wetbench](#)
- References
  - [Wikipedia Entry on Phosphoric Acid](#)

### Sulfuric Acid

- **Caution - Reacts strongly with water - observe proper mixing techniques.**
  - Used in the making of [Piranha Clean](#)
  - Tools
    - Used in [MOS RCA Bench](#)
    - Used in [General RCA Bench](#)
    - Used in [Manual Processing 2 Wetbench](#)
    - Used in [Manual Processing 4 Wetbench](#)
  - References
    - [Wikipedia Entry on Sulfuric Acid](#)
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## Specialty Etches

### [Aluminum Etch](#)

- Mixture of Nitric Acid, Acetic Acid, Phosphoric Acid and water.
- Is manufactured in formulations with and without surfactants.
- Tools
  - Used in [Al Etch & Solvent Strip Wetbench](#)
- References
  - [Fujifilm Product Sheet](#)

### [Buffered Oxide Etch \(BOE\)](#)

- **Caution - treat as if this chemical were Hydrofluoric Acid - Poses similar risks.**
  - See the [SMFL Safety Information about Fluorine Poisoning Compounds](#)
- BOE is a mixture of Hydrofluoric Acid with Ammonium Fluoride used to etch silicon dioxide in a more controlled fashion than just hydrofluoric acid.
  - It is a mixture of 49% HF & 40% NH<sub>4</sub>F - common mixtures range from 5:1 (NH<sub>4</sub>F:HF) to 50:1.
  - May contain surfactants for wetting and etching of small features.
  - Extra fluorine acts as a buffer to preserve etch rate due to load effects or bath aging over just a HF bath.
  - As the ratio gets stronger, the ammonium fluoride comes out of solution at higher temperatures.
    - A 5:1 mixture will form crystals in the bath at temperatures below 64F
- Tools
  - Used in [BOE / HF Wetbench](#)
  - Used in [Nitride & Silicon Etch Wetbench](#)
- References
  - [Information on BOE from FujiFilm](#)
  - [Information on BOE from General Chemical](#)
  - [Wikipedia entry on BOE](#)
  - [Wikipedia entry on BOE](#)

### [Freckle Etch](#)

- Freckle Etch is a specialty etchant that is used to remove residual silicon nodules left after etching aluminum-silicon films used in PVD Sputtering.
- The silicon present in these PVD films is not soluble in wet aluminum etchants and will form nodules on the wafer surface.
- Tools
  - Used in [Nitride & Silicon Etch Wetbench](#)
- References
  - [Wikipedia entry on Fluoroboric Acid](#)
  - [Freckle Etch Product Sheet from FujiFilm](#)

### [Pad Etch](#)

- **Caution - treat as if this chemical were Hydrofluoric Acid - Poses similar risks.**
    - See the [SMFL Safety Information about Fluorine Poisoning Compounds](#)
  - Pad Etch is an ammonium fluoride mixture used to etch oxide that has been deposited over aluminum.
  - Once through the oxide, the pad etch will not harm the underlying Al as quickly as an HF etch would.
  - Is manufactured in formulations with and without surfactants.
  - Tools
    - Used in [BOE / HF Wetbench](#)
    - Used in [Nitride & Silicon Etch Wetbench](#)
  - References
    - [Pad Etch Product Sheet from FujiFilm](#)
    - [Older Pad Etch Product Sheet from Arch / FujiFilm with etch rates](#)
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## Bases

### Potassium Hydroxide

- Used for bulk etching of silicon. SMFL incoming solution is 45%.
- Potassium (an alkali metal ion) will severely degrade device performance and represents a contamination threat to the lab.
- KOH may be used only at [Phosphoric & KOH Wet Bench](#).
- Any substrate that has been exposed to KOH must go through an [HCl decontamination process](#) before going on to other tools in the lab.
- Tools
  - Used in [Nitride & Silicon Etch Wetbench](#)

### Ammonium Hydroxide

- Used in the RCA Clean process
- SMFL incoming solution is 29%.
- Tools
  - Used in [MOS RCA Bench](#)
  - Used in [General RCA Bench](#)

### Tetramethyl Ammonium Hydroxide

- Commonly known by its acronym TMAH
  - **Warning** May be fatal if swallowed, inhaled or absorbed through skin
  - TMAH is used in an alkali solution (corrosive) in the development of photoresist. It is known as a Metal-Ion Free developer as compared to other photoresist developers based on Sodium Hydroxide (NaOH). The sodium ion represents a contamination threat to integrated circuits.
  - Typical concentrations for photoresist developers are <5% solutions.
  - TMAH is also a isotropic etchant of silicon and etches preferentially along the silicon crystal planes.
  - Tools
    - Used in [Manual Processing 1 Wetbench](#)
    - Used in [Manual Processing 2 Wetbench](#)
    - Used in [Manual Processing 3 Wetbench](#)
    - Used in [Manual Processing 4 Wetbench](#)
    - Used in [SVG 88 Coat/Develop Track&](#)
    - Used in [CEE Manual Developer](#)
  - References
    - [Wikipedia TMAH Entry](#)
    - [Good primer on photoresist developers from Microchemicals Inc.](#)
    - [Good primer on silicon etching with TMAH from Microchemicals Inc.](#)
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## Solvents / Strippers

### NMP

- Acronym for N-Methyl-2-pyrrolidone
- Common component of many photoresist strippers such as Remover PG and PRS-2000
- Tools
  - Used in [Al Etch & Solvent Strip Wetbench](#)
- References
  - [Wikipedia NMP Entry](#)

### PRS 2000

- NMP based solvent photoresist stripper manufactured by Baker Mallinckrodt
- Tools
  - Used in [Al Etch & Solvent Strip Wetbench](#)
- References
  - [Data sheet for PRS 2000](#)

### Remover PG

- NMP based solvent stripper.
- Primarily used to remover SU8 & LOR 5A, 10A Liftoff Photoresist materials
- Tools
  - Used at the Manual Processing Wetbenches
- References
  - Manufactured by Microchem
  - [Remover PG Data Sheet](#)

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## Other

### Hydrogen Peroxide

- **Use with caution! Very strong oxidizer**
- Hydrogen peroxide decomposes to form water and oxygen. The decomposition rate varies with temperature, contaminants and pH (higher temp and higher pH speed up the process)
- Hydrogen peroxide must be stored in properly vented containers.
- Used in the making of [Piranha Clean](#) and in the RCA Clean process
- References
  - [Wikipedia entry on Hydrogen Peroxide](#)
- Tools
  - Used in [MOS RCA Bench](#)
  - Used in [General RCA Bench](#)
  - Used in [Manual Processing 2 Wetbench](#)
  - Used in [Manual Processing 4 Wetbench](#)

### Spin on Glass

Spin on glass is a generic term that describes a variety of compounds.

- Dielectric Applications
- Dopant Applications
  - [Emulsitone Phosphorous Diffusion Source](#)
  - [Emulsitone Boron Diffusion Source](#)

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## Dry Etch Gases

### Boron Trichloride

**Boron Trichloride is highly toxic.**

\*Boron trichloride is used in the aluminum dry etch process. It etches the native Al<sub>2</sub>O<sub>3</sub> layer so that the chlorine can etch the aluminum.

- References
  - [Wikipedia entry on Boron Trichloride](#)
- Tools
  - Used in [LAM 4600 Al Etcher](#)

### Chloroform

- Chloroform is used in the dry etching of aluminum. It is used in the formation of polymer sidewalls to give anisotropic etch profiles.
- Chemical formula is CHCl<sub>3</sub>.
- References
  - [Wikipedia entry on chloroform](#)
- Tools
  - Used in [LAM 4600 Al Etcher](#)

### Chlorine

**Chlorine is highly toxic, corrosive, and a strong oxidizer.**

- Chlorine is used for dry etching of aluminum.
- Tools
  - Used in [LAM 4600 Al Etcher](#)

### Sulfur Hexafluoride

- Chemical formula is SF<sub>6</sub>
- Typically used for etching silicon and silicon nitride.
- Much heavier than air - Mythbusters and others have done cool experiments with this "[invisible water](#)"
- References
  - [Wikipedia entry on Sulfur Hexafluoride](#)
- Tools
  - Used in [LAM 490 Plasma Etcher](#)

### Tetrafluoromethane

- Chemical formula is  $CF_4$
- Typically used for dry etching of silicon dioxide.
- References
  - [Wikipedia entry on Tetrafluoromethane](#)
- Tools
  - Used in [Trion Minilock Etcher](#)
  - Used in [AME P5000 Chamber C](#)

### Trifluoromethane

- Chemical formula is  $CHF_3$
- Typically used for dry etching of silicon dioxide.
- References
  - [Wikipedia entry on Trifluoromethane](#)
- Tools
  - Used in [Trion Minilock Etcher](#)
  - Used in [AME P5000 Chamber C](#)

### Xenon Difluoride

- Chemical formula is  $XeF_2$
  - Used for dry etching of silicon in bulk release MEMs applications
  - **Very strong oxidizer.**
  - Can react with water/moist air to form hydrogen fluoride.
  - Do not let  $XeF_2$  come in contact with combustibles/organic solvents.
  - References
    - [Wikipedia entry on Xenon Difluoride](#)
  - Tools
    - Used in [Xactic\\_Etcher](#)
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## Deposition Gases

### Ammonia

- Chemical formula is  $NH_3$
- At room temperature, ammonia is a gas with very pungent odor.
- Used in conjunction with Dichlorosilane to grow silicon nitride
- References
  - [Wikipedia entry on Ammonia](#)
- Tools
  - Used in [LPCVD ASM LPCVD Tube 2](#)
  - Used in [AME P5000 Chamber B](#)

### Dichlorosilane

**Dichlorosilane is highly flammable and toxic**

- Chemical formula is  $H_2SiCl_2$  - or known by the acronym of DCS
- DCS is mixed with Ammonia ( $NH_3$ ) in LPCVD chambers to grow silicon nitride
- Tools
  - Used in [LPCVD ASM LPCVD Tube 2](#)
  - Used in [AME P5000 Chamber B](#)

### Silane

- Chemical formula is  $SiH_4$
- At room temperature, silane is a gas, and is pyrophoric
- Used as a source of silicon for the growth of polysilicon in LPCVD.
- References
  - [Silane Wikipedia entry on Silane](#)
- Tools
  - Used in [LPCVD ASM LPCVD Tube 1](#)
  - Used in [LPCVD ASM LPCVD Tube 2](#)
  - Used in [AME P5000 Chamber B](#)

### Tetraethyl Orthosilicate

- Also known by the acronym TEOS - Chemical formula is  $\text{Si}(\text{OC}_2\text{H}_5)_4$
- Used as a source of silicon for PECVD deposition of silicon dioxide.
- References
  - [Wikipedia entry on TEOS](#)
- Tools
  - Used in [AME P5000 Chamber A](#)