Substrate Cleaning Adhesion Promotion

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www.microchemicals.com/downloads/application_notes.html

Cleaning

In case of clean substrates (virgin wafer or wafer with fresh thermal oxide), baking at 120°C-140°C for some minutes is sufficient for the desorption of H_2O. The coating should be performed directly after cooling down of the substrates in order to avoid re-adsorption of water.

Substrates contaminated with particles/organic impurities can be prepared with a two-stage substrate cleaning for the improvement of the resist wetting and adhesion: Acetone removes organic impurities, a subsequent rinse in isopropyl removes the contaminated acetone thus avoiding striations. We supply acetone and isopropyl in VLSI and ULSI quality also in small sales volumes.

Piranha-Etch and RCA Cleaning

In case of a more significant contamination (organic/metals), or, respectively, before contamination-critical high-temperature steps, Si-wafer can undergo a so-called piranha-etch with subsequent RCA-cleaning:

- In the piranha-etch (H_2O_2 (25 %) : H_2SO_4 (97 %) = 1:2) SiO_2 grows into the Si, so the buried SiO_2/Si interface keeps clean.
- After SiO_2 removal in diluted HF (typ. 1-5 %), RCA-1 (H_2O_2 (25 %) : NH_4OH (25 %) : H_2O = 1 : 1 : 5) at 70-75°C for 10 minutes is applied.
- The approx. 10 ... 15 Å SiO_2 hereby grown is again removed in diluted HF.
- The next step is RCA-2 (HCl (30 %) : H_2O_2 (25 %) : H_2O = 1 : 1 : 8) at approx. 80°C for 10 minutes. A subsequent HF (1-5 %) dip removes the SiO_2 grown hereby.

Resist Wetting and Adhesion after HF Etching

After SiO_2-etching with HF (e. g. 'HF-dip'), the resist adhesion strongly depends on the completeness of SiO_2 removal: With SiO_2 completely removed, the now H-passivated Si-surface (left-hand) reveals a very good adhesion, while remaining oxide (right-hand) causes a very bad and non-reproducible adhesion, which can be restored at > 700°C.

Resist Adhesion on Metals

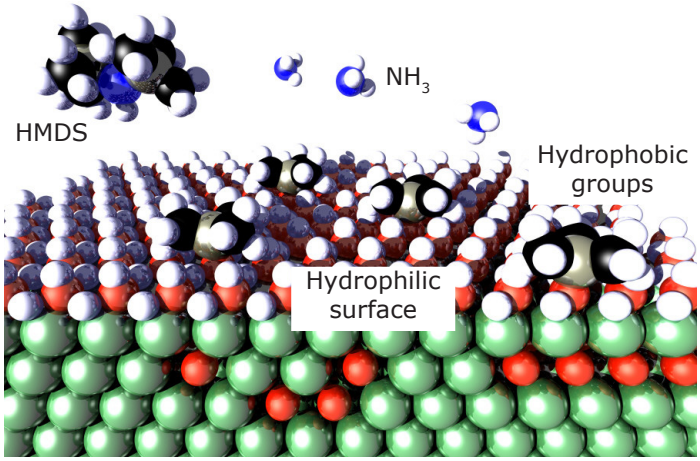
Metals such as aluminium or titanium generally reveal a very good resist adhesion, while the wetting and adhesion on noble metals (silver, gold) often is worse. In this case, resists such as AZ® 111 XFS or AZ® 1514H often reveal an improved adhesion.

Substrates coated with different metals on both sides may cause a galvanic cell in aqueous solutions, accompanied by gas (H_2-) formation under the resist peeling it from the substrate. A protective (resist) coating with AZ® 520D on the 'rear side' of the substrate will help in this case.

Adhesion Promotion: Basics

On SiO_2 and many metals surfaces, the air humidity forms polaric OH-bonds. Such substrates are hydrophilic (good adhesion of water), but reveal a bad wetting and adhesion of the unpolaric resist. Adhesion promoters such as HMDS or TI PRIME make hydrophilic surfaces hydrophobic (water rolls off the substrate surface) thus improving the resist adhesion.

Adhesion Promoter HMDS

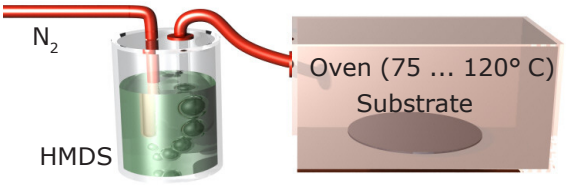


On water-free surfaces, HMDS chemically bonds with its Si atom to the oxygen of oxidized surfaces, accompanied by the release of ammonia (NH_3). Hereby, OH-groups which form hydrophilic surfaces with inferior resist adhhesion are cracked.

The methyl groups of the HMDS fragment hereby form a hydrophobic surface thus improving resist wetting and adhesion.

The **correct application of HMDS** is very important in order not to further deteriorate the resist adhesion: In a so-called bubbler, water-free nitrogen saturates at room temperature with HMDS vapour. The N2 + HMDS streams onto the heated (75 ... 120°C), water-free substrate hereby forming a monolayer of chemically bond $Si(CH_3)_3$ groups responsible for the desired hydrophobic characteristics.

In case of spin-coating of HMDS, a too thick HMDS film forms on the surface. After resist coating during the softbake, this excess of HMDS releases ammonia which diffuses into the resist and crosslinks the resin near the substrate. As a consequence, through-development sometimes becomes impossible.



We supply HMDS in VLSI- and ULSI quality also in 1 L bottles.

Adhesion Promoter TI PRIME

The application of TI PRIME is much more easy: TI PRIME is spincoated and forms a physically bonded sub-monolayer of the active compound after solvent evaporation.

Subsequently, a baking step of the primed substrate at approx. 120°C chemically activates the adhesion promoter thus forming the desired hydrophobic surface allowing subsequent resist coating with improved wetting and adhesion. We supply TI PRIME in 1 L and 2.5 L bottles.