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Application Data Sheet

Chemical Cleaning after Thinning, Backside Grinding, Lapping, or Polishing of Silicon or Gallium Nitride Substrates

Wafer cleaning after thinning, backside grinding, polishing, or lapping of silicon or gallium nitride substrates has proven to be a difficult task. Particles are attached to the substrate through an electrostatic charge created during the silicon removal process. Other contaminates may include inorganic metals/salts and organics such as fingerprints and oils. There are three predominate cleaning methods used to remove these contaminants from wafers.

Cleaning Methods:

One cleaning method used to remove particulates from silicon wafers is mechanical scrubbing. A typical mechanical scrubbing process consists of a rotating brush that sprays the surface of a wafer with a jet of high pressure DI water and cleaning solution. The brush does not actually make contact with the wafer surface; instead, an aquaplane is formed across the wafer surface which transfers momentum to the DI water. One disadvantage to using this cleaning method is that brushes can become overloaded with contaminants and redeposit particulates back on the wafers. Continued cleaning with overloaded brushes can also cause scratches on the surfaces of the wafers.

A second cleaning method used in the silicon wafer fabrication process is a high pressure DI wafer scrubbing system. The wafer is spun while an oscillating spray is directed onto the wafer surface. After cleaning, the wafer is subjected to a pure nitrogen gas purge to promote rapid drying. This method does not remove organic contamination well, so a follow-up bath of organic cleaners such as SC1 and SC2 is often added. Costs associated with performing additional cleaning steps and purchasing the equipment needed for this cleaning process are the major disadvantages associated with this cleaning method.

A third cleaning option, and the most cost effective, is an ultrasonic/megasonic cleaning consisting of immersing the wafer in a filtered, heated liquid medium. The energy agitation of the ultrasonic/ megasonic washers causes microscopic bubbles to form and collapse, creating shock waves that loosen and displace particles. This process works well for wafer thinning, backside grinding, lapping or polishing. Ultrasonic cleaning is the most aggressive method of removing particles. Megasonic scrubbing is sometimes used as an alternative source of wave generation to minimize the damage to thin films. This method is the most economical and effective method for cleaning silicon wafers.

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While a typical ultrasonic medium is a 1:2:20 $NH_4OH/H_2O_2/DIH_2O$ solution, Haemo-Sol has developed a line of powdered detergent products that are effective in removing particles and organic contamination. These low toxicity detergents are highly concentrated and extremely soluble. If used as directed, they are very stable. The detergents have a pH between 10 -12 and are very active in removing any inorganic and organic contamination.

Haemo-Sol Products:

Haemo-sol offers several products that can be used for silicon wafer cleaning. These products were designed to be incorporated into customer's specific cleaning processes and procedures. A summary of each applicable product is given below.

Haemo-Sol Regular (026-050) is the most widely used detergent for this application. It's used in most applications where soak-and-rinse cleaning practices are required. This formulation can remove both organic and inorganic contaminates. A 1% solution has a pH of 10-11 and contains anionic surfactants. The detergent is non-hazardous, non-toxic, non-flammable, and non-corrosive. It contains sodium carbonate and urea as part of the chemical composition. Refer to MSDS 026-050 for more information.

Haemo-Sol Non-Sudsing (026-051) is a non-sudsing product. A 1% solution has a pH of 11-12 and contains non-ionic surfactants. The detergent is non-hazardous, non-toxic, non-flammable, and non-corrosive. It contains sodium tripolyphoshate, sodium carbonate, sodium metasilicate, and ethylene/propylene oxide copolymer. Refer to MSDS 026-051 for more information.

Haemo-Sol Non-Phosphate (026-058) is a phosphate-free chemical composition designed to be especially environmentally friendly. It is used in most applications where soak-and-rinse cleaning practices are required. A 1% solution has a pH of 10-11 and contains anionic surfactants. The detergent is non-hazardous, non-toxic, non-flammable, and non-corrosive. It contains sodium carbonate and urea as part of the chemical composition. Refer to MSDS 026-058 for other information.

Equipment Requirements:

Haemo-Sol is most effective when used in hot, filtered ultrasonic or megasonic baths. The detergent dissolves organic contaminates, while the ultrasonic or megasonic washers promote the de-attachment of inorganic particles. Subsequent rinses with a hot ultrasonic or megasonic continuous flow rinse tank system, or a quick dump rinse (QDR) tank also promote particle de-attachment. A typical wet bench layout is shown below:

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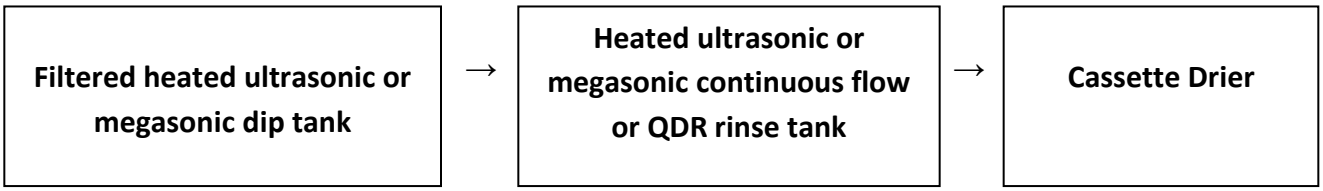
Wet Bench Layout



There are a number of modifications that can be made to the wet bench process to increase throughput and improve efficiencies including, but not limited to, the following:

- Add a second dip tank and a second rinse tank to the process.
- Add a mechanical XYZ robot to automate the process and move the product from tank to tank.
- Add a mechanical arm to each tank. This will allow the operator to move the wafers from one bath to another, while the mechanical arm moves the wafers in the Y direction.

Process Requirements:

Tank Setup

The process is heavily dependent on the size of the wafers and the amount of contamination being removed. The ultrasonic tanks will remove the particles held by electrostatic charge and the detergent will remove organic materials. In some cases, a third dip tank is added to dissolve inorganic metals and salts before going through the rinse cycle. A typical tank setup is given below:

1. A 1% solution is mixed in dip tanks and heated to $70^{o}C – 80^{o}C$. The detergent is very soluble in water and should dissolve immediately. If it does not, a simple stir of the bath should be enough to dissolve the remaining powder. While megasonic or ultrasonic frequency depends on the size and amount of the particles being removed, frequencies between 20 KHz and 40 KHz are most commonly used.
2. The water temperature in the ultrasonic or megasonic continuous flow, or QDR rinse tanks should be maintained within the range of 70°C – 80°C.
3. Drying after the wafers are rinsed can be performed with a spin-rinse drier or IPA drier.

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Cleaning Process

1. The cassette of wafers is placed in the first dip tank for approximately 10 minutes.
2. The wafers are removed and placed in the second dip tank for 10 minutes. When moving from one tank to another, minimize the amount of time the wafers remain outside of the dip and rinse tanks. Particles that have dried on the wafer surface will be more difficult to remove.*
3. The wafers are placed in the second rinse tank for 6-8 minutes.
4. The wafers are removed and placed in the cassette spin-rinse drier.

Note: It should be noted that the above process times may vary according to the size and amount of contamination being removed from the wafers, as well as the number of wafers being cleaned during each dip. At no time should the wafers be held out of the bath to dry until the final drying phase.

Bath Life:

The life of the bath depends on the amount of use and the density of particles being removed. Normally, the bath can be changed after 8 hours of use. The tank should be dumped, cleaned (side and bottom), and spray rinsed before making a new bath.

Disposal:

In most cases, the dip and rinse tanks can be slowly dumped into the acid drain or directly into the sewer drain. DO NOT DUMP into a solvent drain or container.

However, since disposal policies differ by country and region, it is recommended that facilities review appropriate regulations to determine the best manner of disposing of spent solutions. Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use, or contamination of this product may change the waste management options. Dispose of container and unused contents in accordance with local requirements.

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Test Data:

References: Haemo-Sol Residue Detection Testing see www.haemo-sol.com under technical info

"Megasonic cleaning of wafers in electrolyte solutions" Microelectronic Engineering vol 86 (2009) pages 132-139

"Fundamentals of Ultrasonic & Megasonic Cleaning" by Blackstone-NET Process Cleaning Magazine December 2009

MSDS 026-050, 026-051, & 026-058 see www.haemo-sol.com