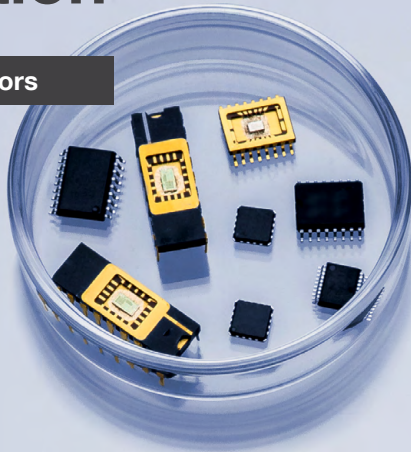


Solutions for **Optimizing Wafer Production**

Semiconductors



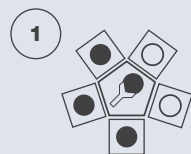
Wafer Production at Its Best

From thin films to testing, assembly, and packaging, our measurement solutions support you at every manufacturing step.

FIND OUT MORE



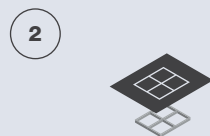
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Thin films

As an integrated circuit (IC) designer and manufacturer, you want to ensure that the materials and layers used in IC production have the correct mechanical properties.

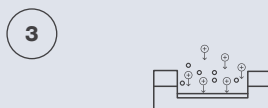
Solution: Characterize the hardness and elastic modulus and adhesion of thin layers on wafers with mechanical surface characterization (using nano scratch testing and low-load indentation testing) to have full control of the deposited functional layers during the integrated circuit development.



Photolithography

You want to avoid contamination of photomasks, which affects the quality of integrated circuits.

Solution: Determine the correlation between different cleaning agents and the photomask by measuring the zeta potential (surface charge analysis). In this way, you can optimize the performance of cleaning procedures for photomasks.



Etching

You want to determine the concentration of the hydrofluoric acid to achieve consistent etching performance.

Solution: Quickly check the acid concentration by concentration measurement with a chemically resistant Hastelloy U-tube density meter, to determine the hydrofluoric acid concentration for reproducible etching processes.



Cleaning

You want to quickly determine the concentration of sulfuric acid approx. 10 times faster than with the traditional titration method.

Solution: Measure density and sound velocity with one instrument (concentration measurement): Due to the non-linear concentration curve of sulfuric acid, both technologies are required. This guarantees high repeatability and reproducibility of the cleaning process.



Planarization, Cutting Electrodes, Cell Assembly

You want to avoid contamination of silicon wafers with different top coatings due to contact with components of the slurry during chemical-mechanical polishing.

Solution: Determine the zeta potential of wafer surfaces and slurry particles with surface charge analysis, to optimize process conditions and avoid particle adhesion through electrostatic interactions. This increases throughput thanks to reduced cycle times in post-CMP cleaning.



Test, Assembly, and Packaging, Filling and Formation

As a semiconductor packaging service provider, you have to make sure that the packaging process is done correctly and the materials used (bond pads, connections, ball grid arrays etc.) have the correct mechanical properties.

Solution: Determine mechanical surface characteristics such as hardness and elastic modulus in local measurements with a nanoindentation tester. This way the highest packaging material quality is ensured. You can guarantee that the integrated circuit (IC) is well-protected and will function perfectly throughout the lifetime of the final product.

Optimized Wafer Production

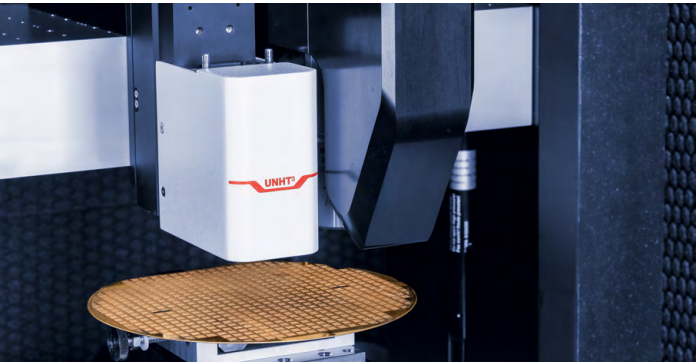


Surface charge and particle size analysis

By analyzing the zeta potential and solid surface charge, SurPASS 3 gives insight into the electrostatic interaction between wafers and their actual environment. Independent of their size, wafer samples can be loaded in the proprietary SurPASS 3 Clamping Cell and characterized destruction-free. A determination of the surface’s isoelectric point reveals the surface chemistry of the outermost material layer. Time-resolved adsorption studies visualize any changes in the surface properties caused by liquid-on-solid surface adsorption and desorption processes in real-time.

The zeta potential of slurry particles can be determined with Litesizer 500, which helps to analyze electrostatic interactions between the slurry and the wafer surface. SurPASS 3 and Litesizer 500 can be used to optimize process conditions and reduce post-CMP cleaning cycles. Furthermore, characterizing the particle size of slurry particles with Litesizer 500 leads to improved polishing performance and reduction of damage to the wafer surface.

Parameters: zeta potential, surface charge, isoelectric point, liquid-on-solid surface adsorption kinetics, particle size, refractive index

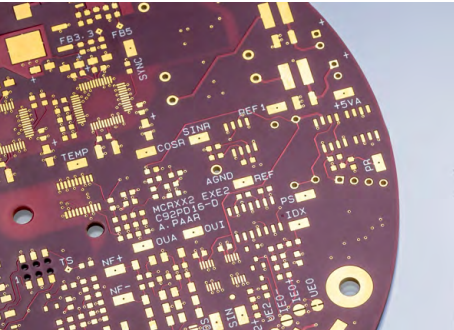
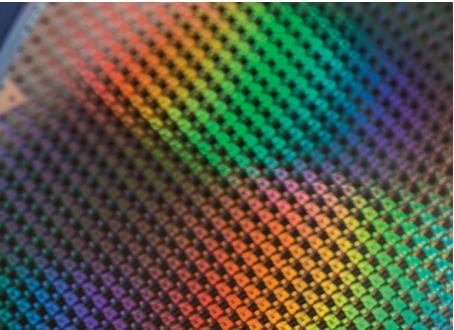


Mechanical surface characterization

For the mechanical surface characterization of wafers, Anton Paar offers two state-of-the-art measuring technologies: scratch testing and instrumented indentation testing. Achieving excellent adhesion and high scratch resistance of functional thin films is very important for wafer and integrated circuit production. The most suitable and easiest method for measuring adhesion is the nano scratch test with an NST³ that uses a diamond tip. UNHT³ is the perfect tool for characterizing most thin films on wafers, e.g. for evaluating the quality of the thin film deposition process by measuring the hardness and elastic modulus during wafer production.

Parameters: thin film adhesion, scratch resistance, hardness, elastic modulus

→ **Density and concentration measurement**



Density and sound velocity meters

The correct concentration of the etching substance is key to getting consistent etching results. Digital density measurement is the ideal method for the highly accurate determination of the concentration of acids and bases in the etching and cleaning process. DMA 4200 M measures the hydrofluoric acid which is used in the etching of oxide layers. The combined density and sound velocity meter DMA 5001 Sound Velocity is used for measuring the concentration of binary and ternary solutions, such as the sulfuric acid required for cleaning and polishing wafers.

Parameters: density, specific gravity, concentration, refractive index, viscosity



Refractometers

To ensure proper cleaning without residues on the wafer surface, the purity of the cleaning agent can be checked using a highly precise refractometer from the Abbemat Performance and Performance Plus line. The goal is to save time and resources by accelerating and improving the cleaning process.

Parameters: density, specific gravity, concentration, refractive index, viscosity

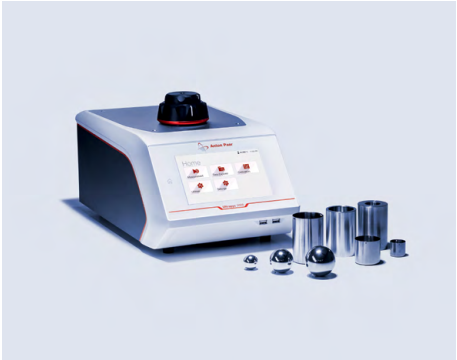
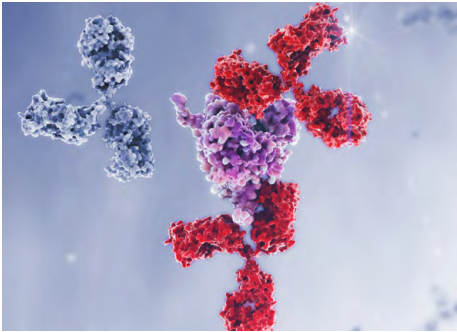
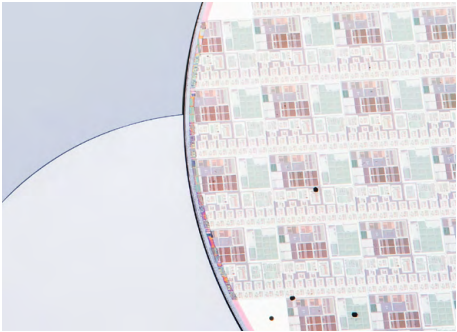
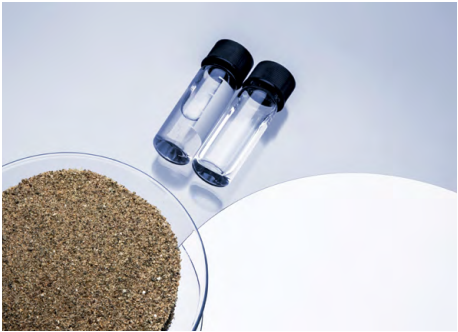


Process sensors

For continuous quality monitoring of your cleaning process, concentration measurement of acids and bases can also be carried out in the process environment with Anton Paar’s high-performance Process sensors L-Dens 7400 and L-Com 5500. These sensors cover the entire concentration range of H₂SO₄ (0 % to 100 %). L-Dens 7400 can also be used for slurry density measurement to inline-monitor your slurry properties in the CMP process. Real-time data indicates slurry health and detects changes in abrasive concentration.

Parameters: density, concentration

| | | | | | |
|---|-------------------------------|---|---|---|---|
| 1 | Thin films | ✓ | ✓ | | |
| 2 | Photolithography | ✓ | | | |
| 3 | Etching | | ✓ | | |
| 4 | Cleaning | ✓ | ✓ | ✓ | ✓ |
| 5 | Planarization | ✓ | | ✓ | ✓ |
| 6 | Test, Assembly, and Packaging | | ✓ | | |



Microwave Digestion

Microwave digestion is the preferred method to prepare materials for subsequent elemental analysis, in order to determine inorganic impurities. This is important in ensuring the quality of base materials and the correct functionality of final products. With Anton Paar's microwaves, each material is prepared in a fast and reproducible way.

Solid Density Analysis

Knowing the open and closed porosity of polishing pads used in the process step of planarization is important when selecting the optimal pad and for the continuity of process parameters. Porosity can be quantified by Ultracyc 5000 Foam, a gas pycnometer which allows you to monitor quality and ensure a consistent microstructure of polishing pads from lot to lot.

Parameters: True density

SAXS

Grazing-incidence small-angle x-ray scattering (GISAXS) can be used to investigate the structural features of thin films. This X-ray method not only allows investigation of the surface structure, but also makes it possible to deliver information on features below the surface, resulting in information about the coating quality and nanostructure distribution of thin films. Anton Paar's SAXSpoint 5.0, a laboratory beamline with synchrotron detector technology, is able to apply this method, as well as SAXS, WAXS, and RheoSAXS studies.

Parameters: Correlation length, Space group, Particle shape, Particle size, Relative roughness

| | | |
|---|-------------------------------|---|
| 1 | Thin films | ✓ |
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