

# SPTS Etch and Deposition for MEMS Manufacturing

Micro-electromechanical systems (MEMS) are devices which combine electrical and mechanical components, usually converting motion into an electrical signal or vice versa. KLA has been at the forefront of MEMS wafer processing technologies since the advent of the silicon MEMS industry in the mid-1990s. Early commercial applications included automotive airbag sensors and inkjet print heads, but in recent years an ever-increasing number of consumer and industrial products have come to depend upon MEMS for sensing or actuation, in products including smartphones, cars, entertainment systems, voice-activated products, biomedical devices and industrial automation.

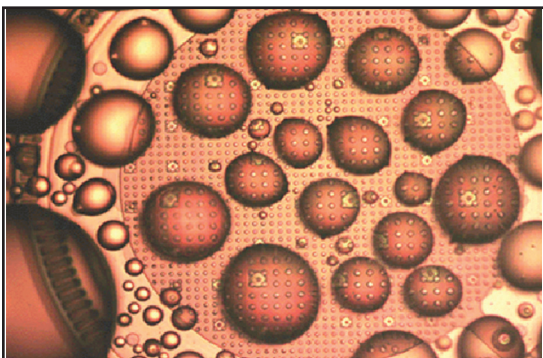
KLA has installed SPTS etch and/or deposition systems in:

- 28 of the Top 30 MEMS manufacturers
- All Top 5 MEMS foundries

Our global network of sales and service offices provides world-class support to our customers throughout Asia, North America and Europe.

Typical plasma etch applications include high rate etching of high aspect ratio MEMS microstructures, in silicon, silicon carbide or oxides, and dry vapor etch to release moving structures within the MEMS devices without corrosion or stiction usually associated with wet release etch processes.

We also offer PVD, PECVD and MVD® to deposit metals, dielectrics and thin film coatings.

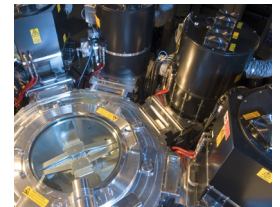


*Hydrophobic coating on MEMS microphone array  
(Courtesy of Knowles Electronics)*

## KLA Products

### SPTS Omega® DSi-v / Rapier™

Established high rate silicon DRIE modules with unique end-point solutions.



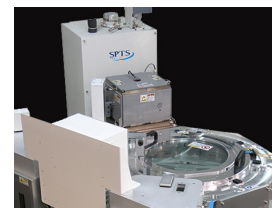
### SPTS Omega® Synapse™

Module with 10x ion density of ICP, to etch strongly bonded materials such as SiC, SiO<sub>x</sub> and highly doped AlScN.



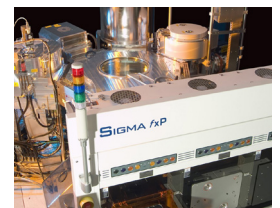
### SPTS Primaxx®/Xactix® Vapor Etch

Dry vapor release etch using either HF or XeF<sub>2</sub> to remove sacrificial Si or SiO<sub>x</sub> without stiction or corrosion.



### SPTS Sigma® PVD

Deposition of AlN or AlScN with excellent film thickness uniformity and stress control.



### SPTS Delta™ PECVD

Deposition of low damage, stress-controlled SiO<sub>x</sub> and SiN layers with unparalleled uniformity and deposition temperatures <200°C.



### SPTS MVD®

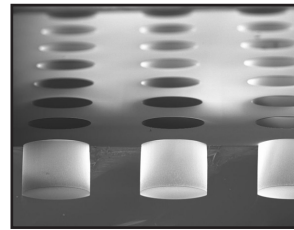
Molecular Vapor Deposition can be used to deposit anti-stiction and anti-corrosion films onto MEMS devices.



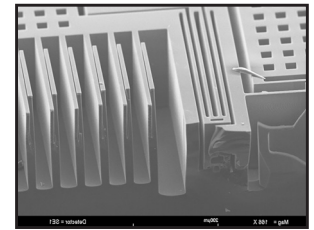
## PLASMA ETCH PROCESSES FOR MEMS

The core building block in MEMS fabrication is deep Si etching; including high rate etching of high aspect ratio through-wafer structures and etching to buried oxide layers, including SOI wafers. Using a patented dual plasma source to deliver a uniform plasma density, our Rapier module improves profile/depth uniformity and minimizes profile tilting.

KLA also offers plasma etch processes for SiC, SiO<sub>x</sub> and piezo materials (including AlScN with >30%Sc).



*Cavity etch for Si MEMS microphone array*

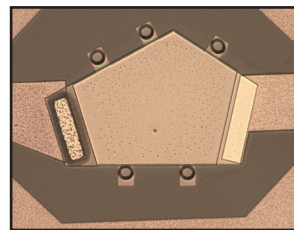


*Si MEMS structure with low tilt <0.1°*

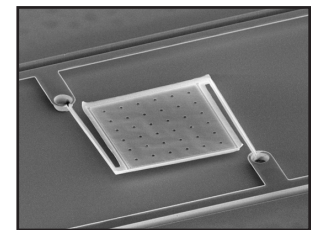
## RELEASE ETCH PROCESSES FOR MEMS

Dry vapor etch utilizes HF or XeF<sub>2</sub> to selectively remove sacrificial silicon or oxide layers to release flexures or other MEMS devices. This provides stiction-free, residue-free etching across a wide range of etch rates.

Key applications for vapor release technology include inertial sensors, mirror arrays, resonators, RF MEMS, micro-actuators and microphones.



*FBAR released using Primaxx® vapor HF etch*



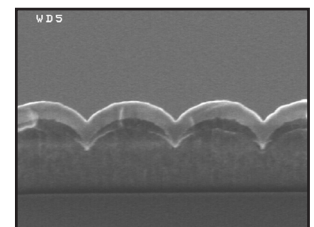
*ALD film bolometer released using XACTIX® XeF<sub>2</sub>*  
(Courtesy of Bosch RTC & Stanford Univ)

## PVD PROCESSES FOR MEMS

KLA has a wide range of PVD process offerings for MEMS applications such as accelerometers and IR detectors (bolometers), and is the market leader in the field of AlN-based resonators. Example applications for AlN include bulk acoustic wave (BAW) filters, Si oscillators, energy harvesters and gyroscopes. We have >15 years' experience with AlN and has developed processes for depositing AlScN films containing >30at.% Sc with excellent thickness and stress uniformity and good control of crystalline defects.

## PECVD PROCESSES FOR MEMS

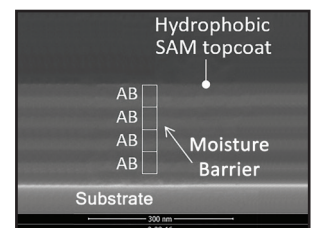
Many MEMS devices contain materials such as polymers, magnetic layers or bonding adhesives, whose properties are degraded by exposure to high temperatures, such as the 350-450°C wafer temperatures typically used in PECVD dielectric processes. Example devices are magnetic sensor passivation for magnetometers, anti-reflective coatings on polymer based micro-optics and via-last TSV dielectric isolation layers for MEMS wafer level packaging. The SPTS Delta™ PECVD system can deposit high performance SiO and SiN films at temperatures <200°C, maintaining device performance at high yield



*Anti-reflective coating on optical color filter*

## MVD PROCESSES FOR MEMS

Molecular Vapor Deposition (MVD®) enables the growth of ultra-thin organic and inorganic films with higher yields and better cost efficiencies than traditional liquid deposition techniques. Such films serve as lubricants, protective, hydrophobic, hydrophilic, biocompatible, or reactive coatings. In MEMS applications, MVD films are typically used as anti-stiction coatings to improve device performance, and enhance overall device lifetime.



*Multilayer moisture barrier*

## KLA SUPPORT

Maintaining system productivity is an integral part of KLA's yield optimization solution. Efforts in this area include system maintenance, global supply chain management, cost reduction and obsolescence mitigation, system relocation, performance and productivity enhancements, and certified tool resale.

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