

**Reactive**

**Gas**

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## Microwave Plasma Products

- GENERATORS
- PLASMA SOURCES
- INTEGRATED DELIVERY SUBSYSTEMS



### Performance

MKS Microwave Plasma Subsystems are fully automatic for hands off operation. Precise power measurement, closed-loop control and automatic plasma tuning ensure high accuracy and repeatability for improved yield.

### Flexibility

Microwave plasma sources, available for fluorine or non-fluorine chemistries, are designed for high power with multiple gases, flows and pressure ranges. The subsystems are lid mountable and configurable to accommodate available chamber real estate. Process

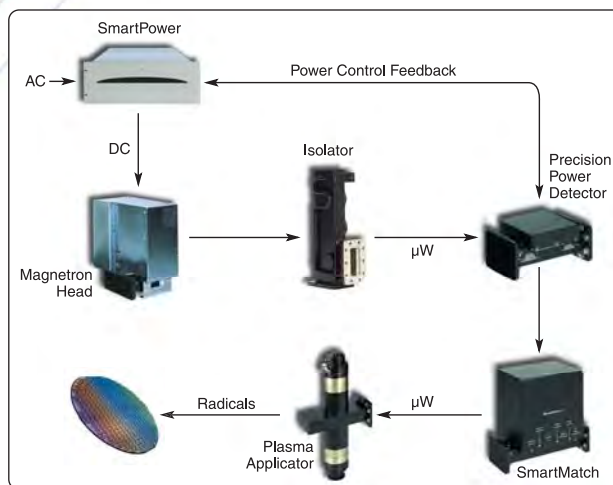
changes are handled by the flexible system software and require no hardware modification.

### Reliability

MKS microwave plasma subsystems are fully integrated and tested for true turn-key implementation. Components have been optimized for long life, reducing CoO. Based on MKS' highly reliable, field proven technology, MTBF exceeds 100,000 hours.

# Microwave Plasma Subsystems

MKS, ASTeX® Products Microwave Plasma Subsystems are fully integrated, highly reliable, and automated products for the cost-effective generation, optimization, and delivery of microwave plasmas for damage-free wafer processing using a variety of process gases. Every precision subsystem includes the SmartPower® microwave power generator, magnetron power head, isolator, SmartMatch® intelligent matching unit, and the patented MKS plasma applicator. MKS microwave products are supported by a team of highly experienced plasma physicists, design engineers and application experts who provide both process and hardware support. The integration of other MKS products (e.g. Vapor on Demand and Pressure Measurement and Control Modules) further optimizes process performance.



Block Diagram of typical Microwave Plasma Subsystem

The SmartPower® generator converts AC to DC power, which is delivered to the magnetron head where microwaves are generated. Microwave power is delivered through the Isolator, which re-directs and absorbs any reflected microwaves, ensuring longer magnetron life and system reliability. The Precision Power Detector (PPD) measures the actual microwave power and provides optimization feedback. Through the use of advanced phase-magnitude detection hardware and software, the SmartMatch® Intelligent Microwave Matching Unit optimizes coupling of power to the plasma for fast, reliable and repeatable matching. In the applicator, the microwaves generate and sustain plasma in the process gas, forming radicals, highly reactive species used in semiconductor processing.



In remote microwave plasma subsystems, the plasma discharge is used to dissociate process gases and produce active atoms (radicals) upstream of the process chamber. Remote microwave plasma subsystems produce a low content of energetic ions. Therefore, the flow of radicals generated in the microwave plasma source can be used for damage-free wafer processing.

#### APPLICATIONS

- Photoresist Removal
- Passivation & Residue Removal
- Surface Modification
- Nitridation
- Oxide Etch
- Deposition
- Silicon Etch
- Remote Chamber Clean

### Microwave Plasma Processing

Remote microwave plasma disassociates a wide range of gases to their atomic form. Applications include hydrogen for native oxide etch, fluorine for silicon etch, oxygen and nitrogen for oxidation and nitration to increase the dielectric constant of gate oxides. Atomic oxygen is widely used for high-rate, damage-free photoresist removal, and atomic fluorine effectively eliminates hard photoresist. Water vapor plasma successfully removes residue and aids post-metal etch passivation.

With high selectivity and minimal dielectric damage, microwave plasma strip processes meet the cleanliness and residue removal requirements of fine device architectures, high aspect ratios and new low-k materials. An ion-depleted downstream microwave plasma has proven superior for achieving a pure dry chemical process and in dual-damascene low-k processes.

### Integrated Microwave Plasma Subsystems

The MKS AX2500 series is a fully integrated subsystem combining a microwave power generator (1.8kW, 3.0kW and 6.0kW power levels), magnetron head and a precision power detector.

The AX2600 series offers a complete custom configured "toplid" solution that includes the AX2500 system as well as the SmartMatch Tuner, Isolator, and Microwave Applicator. Based on MKS' highly reliable, field proven microwave plasma technology, the AX2600 provides



**AX2600 Series —**

3kW subsystem with integrated VoDM (top left), and fully enclosed 3kW subsystem (bottom right)



**AX2700 Series —**

SmartSet components

precise microwave power measurement, feedback and control to ensure high accuracy and fine control of plasma processes for fluorine or non-fluorine chemistries. Automatic tuning matches different plasma conditions at high speed - Resulting in quick plasma ignition - even with difficult plasma load conditions such as  $NF_3$  chemistries. The robust and flexible system software accommodates simple process modifications.

### SmartSet AX2700 Series

The AX2700 Series, available in 1.8, 3, and 6kW, consists of all components necessary for microwave plasma processing for applications where MKS customers take responsibility for on-chamber microwave components integration. All components of the SmartSet are highly reliable, factory tested and field proven.



## In-House Plasma Process Expertise

Process optimization is an essential step in developing an efficient plasma process to minimize cost while achieving the intended result. The fastest and most effective way to optimize the process is to work with experts and run the product under the conditions it will see. MKS, ASTeX Products has a fully equipped plasma lab and staff of recognized plasma scientists able to assess requirements and recommend the most effective approach. Having plasma expertise in-house, MKS provides not only routine applications support, but our scientists are able to provide lab simulations to aid with process development and integration issues to insure an optimized process.



Plasma applications lab



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