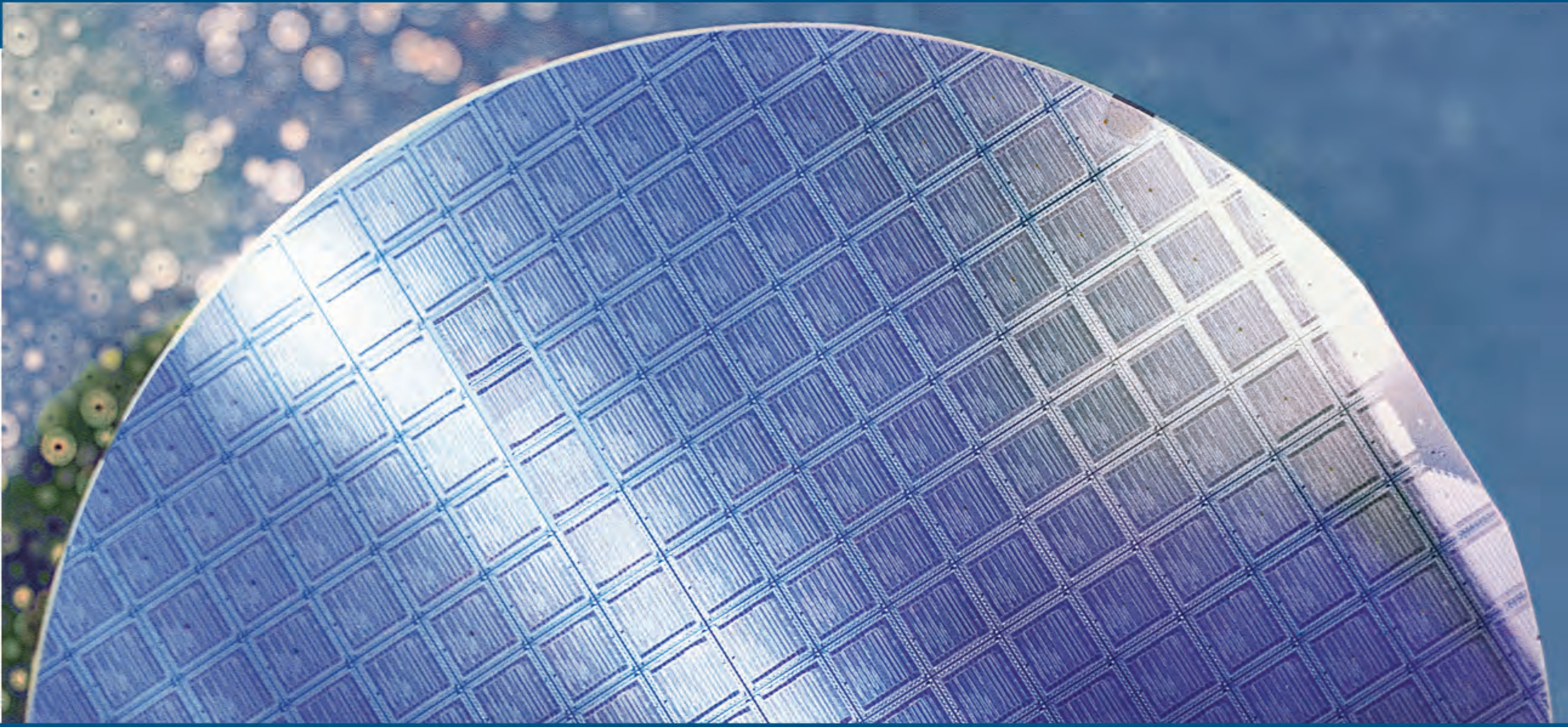
mks
Technology for Productivity

PROCESS SOLUTIONS FROM MKS . . .

# Dry Etch



## CHALLENGES OF DRY ETCH

Etching, the process by which material is removed from a wafer during the fabrication of integrated circuits, has evolved significantly over the past 30 years. Wet etch, a highly selective but isotropic process, was the primary method of etching and cleaning wafers for many years. The introduction of more advanced materials that are difficult to etch, and the evolution toward smaller line widths and deeper, narrower trenches, have lead to the widespread transition from wet to dry etch.

In addition to the typical requirements of most semiconductor processes, there are very specific challenges for dry etch. One critical parameter is selectivity, a measure of the rate at which the material to be removed is etched away, versus the rate at which other exposed materials are etched. Ideal selectivity would result in a fast etch rate for the material to be removed, with little or no etching of all other materials. Another important requirement of the etch process is directionality. Anisotropic etching, the propensity to etch in one direction, is desired because it results in clean, vertically straight walls after the etch process.

| | Reactive Ion Etching | Plasma Etching | Sputter Etching | Ion Milling | Ion Beam Assisted Etching | Reactive Ion Beam Etching |
|---|---|---|---|---|---|---|
| Gas Type | Reactive | Reactive | Inert | Inert | Inert | Reactive |
| Pressure | 100 mT | 1 mT | 100 mT | 1 mT | 1 mT | 1 mT |
| Direction | Anisotropic/ Isotropic | Anisotropic/ Isotropic | Anisotropic | Anisotropic | Anisotropic/ Isotropic | Anisotropic/ Isotropic |
| Energy Bombardment | High | Low | High | High | High | High |
| Etch Rate | Tunable | Low | Low | Medium | High | High |
| Complexity | Low | Low | Low | High | High | High |
| Etch Type | Deep | Medium/ Deep | Surface Treatment | Surface Treatment | Deep | Deep |

Dry etch technology has been greatly refined, optimizing selectivity for today's advanced materials and ensuring anisotropic etching which allows for clean and precise patterns on each die. The most prevalent and advanced dry etch processes are based on plasma. Today's technology combines highly selective dry chemical etching with physical etch. A plasma source is instrumental to both processes.

**The most advanced dry etch systems are designed to provide a controlled balance between selectivity and anisotropy. This balance is achieved through the use of leading edge system components, measurement devices, process information and control systems. MKS is the leading manufacturer of many components required to meet these difficult challenges. We have a strong history of providing effective solutions for the most demanding processes and delivering the tools necessary to maximize yield and throughput.**

# Dry Etch

### AX2500 SERIES SMARTPOWER® MICROWAVE POWER GENERATORS

*Reliable microwave power generator for demanding semiconductor fabrication and industrial applications*

- Wide range of available power levels for process flexibility
- Microprocessor-controlled filament cutback extends magnetron tube lifetime lowering CoO
- Accurate power measurement and feedback ensures high repeatability

### 627C/628C BARATRON® PROCESS MANOMETERS

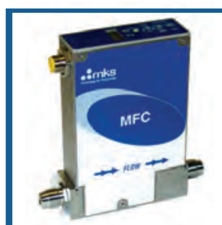
*Accurate and reliable measurement of etch process chamber pressures*

- High measurement accuracy tightens the process window ensuring superior process control and repeatability
- Embedded diagnostics for reliability and control

### R*EVOLUTION® III REMOTE PLASMA SOURCE

*Ultra clean source of reactive gas species for dry chemical strip applications*

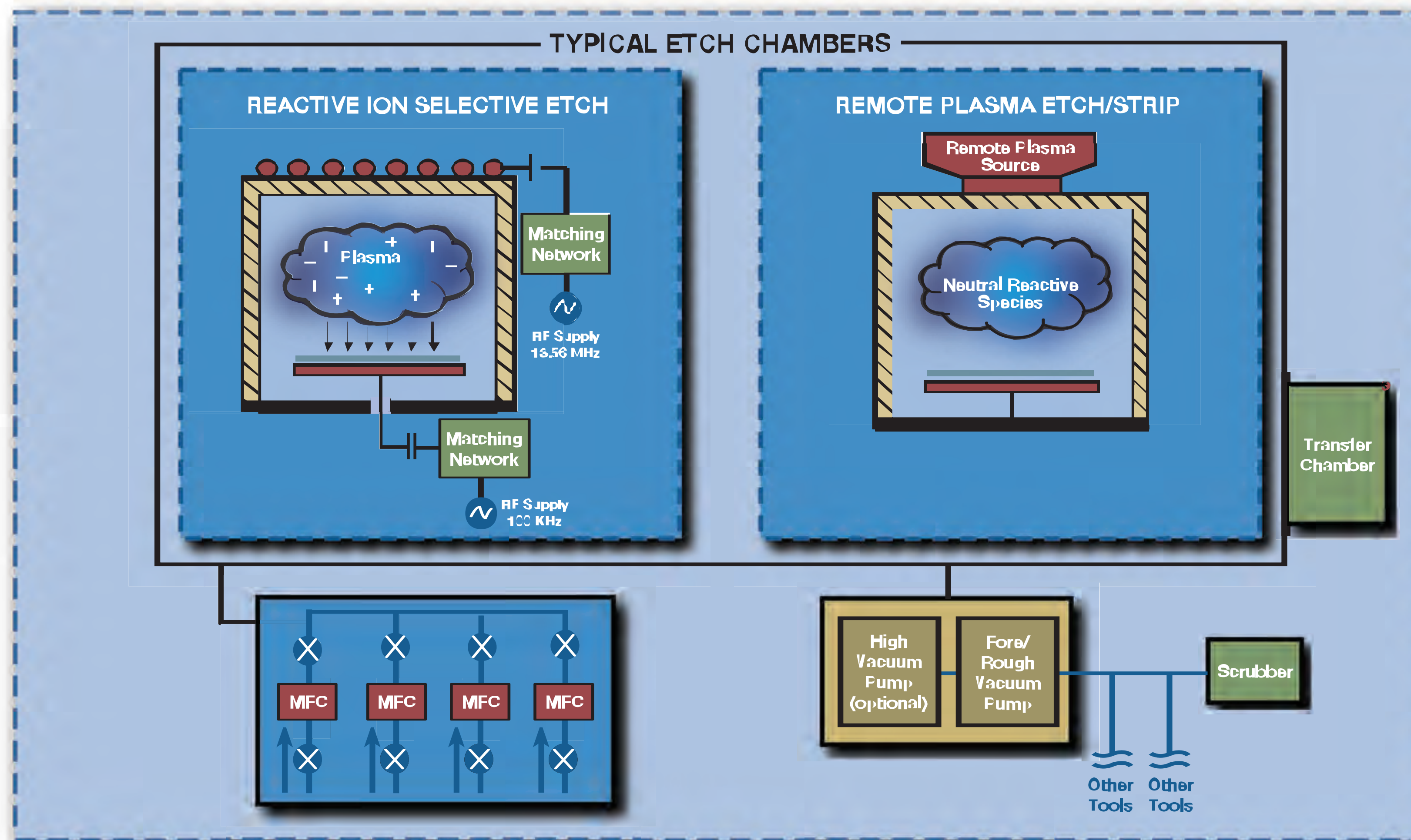
- Exceptional plasma power results in highly efficient wafer stripping for reduced cycle times and improved throughput
- Quartz plasma body ensures high purity, active gas species for exceptional selectivity and etch rate uniformity



### P-SERIES DIGITAL MFCs

*Real-time mass flow control and delivery of strip and selective etch process gasses*

- Accurate and reliable flow control for exceptional step change repeatability and higher yields
- High tolerance to system pressure disturbances ensures precise gas delivery for every cycle
- [illegible] ms response for precise pressure control



### DELTA™ II FLOW RATIO CONTROLLER

*Critical etch process optimization through precise flow distribution*

- Precise dual zone gas control for greater etch uniformity, improved repeatability and higher yields
- Fewer components than dual MFC stick arrangements means greater system reliability and lower cost-of-ownership

### MULTIGAS™ 2030

*Sensitive exhaust monitoring of VOCs, acids, bases, hydrides, and PFCs*

- Minimum sensitivities from [illegible] to [illegible] ppb ensures accurate detection of etch effluent for environmental regulatory compliance and faster process qualification
- Permanent calibration spectra reduces the need for costly gas cylinders

### SUREPOWER® RF PLASMA GENERATOR

*Accurate, high powered plasma generation system in an integrated, compact package*

- Forward power accuracy of ±1% of set point ensures repeatable process performance and greater yields
- Protection circuitry limits reflected power allowing the amplifier to survive adverse load conditions such as plasma transients and arcs

### *FabStat* REAL-TIME MONITORING, PREDICTION AND FAULT DETECTION

*Real-time fault detection and classification (FDC) in semiconductor manufacturing*

- Stand-alone application designed to seamlessly integrate into your existing fab data management system
- Reduces downtime by quickly identifying faults, their cause, and their solution

### 901P MICROPIRANI™ / PIEZO LOADLOCK TRANSDUCER

*Absolute multi-sensor vacuum pressure measurement from $1x10^{-5}$ to 1000 Torr*

- Multi-sensor technology results in accurate and repeatable performance over a wide measurement range for improved process control and reduced cycle times
- Gas independent pressure measurement from [illegible] to 1000 Torr provides a true indication of load lock pressure for all purge gases

### T3P SERIES PENDULUM VALVE

*Integrated isolation and pressure control system*

- High valve actuation speed and precise pressure control over a wide dynamic range ensures tight etch rate control and uniformity
- Excellent conductance control over the entire valve stroke enables pressures to be reached quickly with minimal overshoot

mks
Technology for Productivity

## PROVEN TECHNOLOGY LEADERSHIP

MKS Instruments is the world's leading supplier of process control solutions that improve productivity in semiconductor and related advanced manufacturing. Our extensive range of instruments, components and integrated subsystems, control and manage critical parameters of the process environment.

Today, our core competencies include pressure measurement and control, materials delivery, vacuum technology, gas composition monitoring, power and reactive gas generation, and control and information management. Our wide range of products, intellectual property and years of process applications experience allow us to provide an exceptional level of value. This unique technological breadth gives us the ability to identify process challenges and provide you with value-added process control solutions.

MKS' technology set is fundamental to meeting the requirements of advanced and leading edge technologies like Reactive Ion Etching (RIE). Extensive process knowledge, proven technology leadership, and a strong patent portfolio make MKS well suited to provide RIE OEM's and end-users with high value solutions that optimize process performance, reduce costs and provide greater ROI.

### GLOBAL SUPPORT

As a worldwide leader in the development and manufacture of advanced instruments and controls for the semiconductor industry, we can support your MKS products. Our service engineers average 7-10 years of industry experience. Service plans include extended warranty, contracts, calibration, 24/7 telephone support and industry-leading training. With 17 calibration and service centers in 13 countries around the globe, we are where you are.

### ENHANCED PRODUCT PORTFOLIO FROM MKS

**628D Baratron® Capacitance Manometer**

*In situ process pressure measurement*

**870/872 Micro-Baratron® Capacitance Manometers**

*Pressure measurement of purge gas delivery systems*

**Jalapeño Series Heated Vacuum Valves**

*Isolation of process chamber and vacuum system while eliminating turbulent pumpdowns*

**Heater Jackets, Traps and Effluent Management Solutions**

*Eliminates condensation and reduces system contamination*

**MicroNode™ I/O Module**

*Monitors and controls precursor delivery valves*

2 Tech Drive, Suite 201
Andover, MA 01810

Tel: 978.645.5500
Tel: 800.227.8766 (in USA)
Web: www.mksinst.com

MultiGas™, DELTA™, MicroPirani™, MicroNode™, and SmartPower® are trademarks; and R*evolution®, SurePower® and Baratron® are registered trademarks of MKS Instruments, Inc. Andover, MA.

Dry Etch Process Solutions - 10/11
© 2006 MKS Instruments, Inc.
All rights reserved.