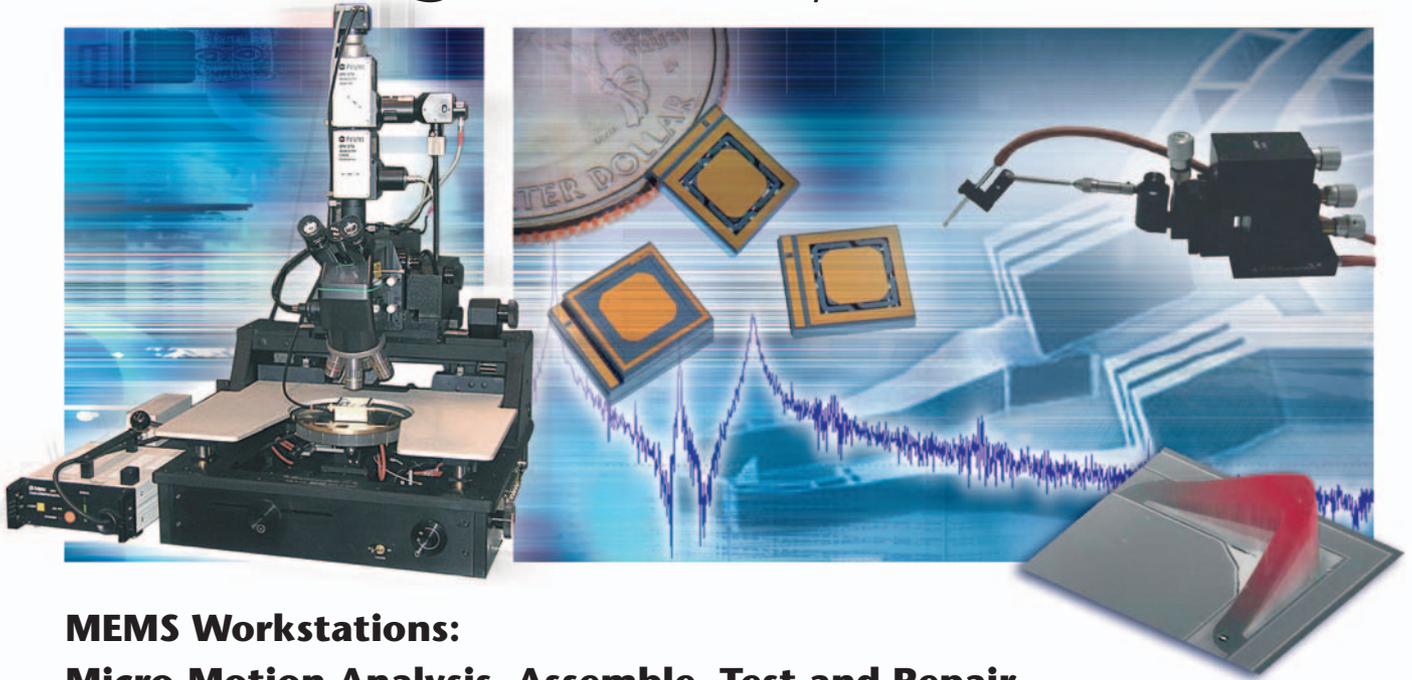


# Technologies Unite *for Success*



## **MEMS Workstations: Micro-Motion Analysis, Assemble, Test and Repair**

*By combining Polytec's motion analyzer systems with a probe station the user can concentrate on the dynamic test rather than on sample holding, positioning and contact issues already addressed by probe station technology. These solutions were found for the early semiconductor and microbiology applications and are easily adapted to MEMS testing.*

### **MEMS Applications and Challenges**

The MEMS industry is challenged to discover, understand and address the novel failure mechanisms associated with different types of MEMS devices. Attempting to ensure device reliability without a full understanding of the basic failure mechanisms will likely result in "unexpected" field failures.

As a breakthrough technology MEMS will solve problems in fields previously unrelated to semiconductor technology with many new MEMS applications and will create products which are currently unidentified or unknown. As such this technology demands a wide range of general purpose tools to support broad testing requirements in research, development and pilot production of MEMS devices. The Polytec motion analyzer systems joined with semiconductor probe stations and a wide range of MEMS tools can provide the functions needed to analyze micro-motion, make electrical and physical contact with MEMS devices, and control the test environment.

The MEMS development process can be very costly. Scientists and engineers design, build and test proto-types then redesign rebuild and retest them. Finally they define the production processes to produce a device and optimize its performance and production yield. Even once a device is in production it is estimated that 65% of its cost is due to test, assembly and packaging. Failure rates for MEMS devices can be very high due to the fragile nature of many MEMS devices before final packaging.

Many MEMS devices have moving parts which may be detected and measured with a Polytec motion analyzer. Some potential applications (see page 14) are accelerometers and gyroscopes, RF MEMS, optical network components (MOEMS) and video displays.

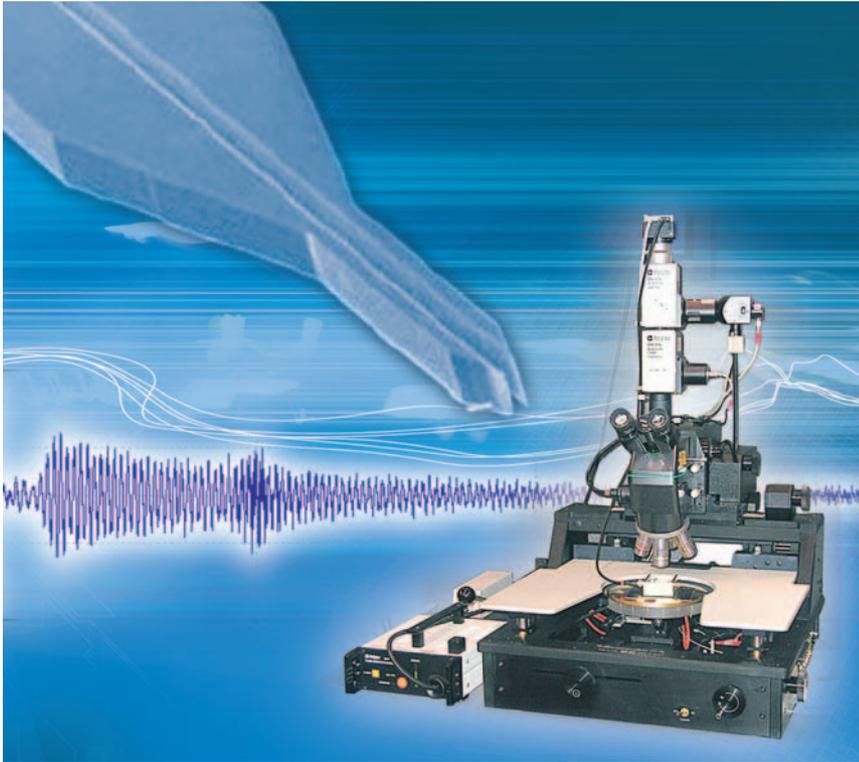
### **Motion Analysis**

The Polytec Micro System Analyzers are the ideal tool for detecting and analyzing MEMS motion. The ability

to precisely measure and analyze out-of-plane and in-plane micro-motion without contact is critical to determine whether a MEMS device is functioning properly and within design specifications. The micro-scanning unit can resolve picometer out-of-plane Z motion within 0 to 20 MHz. The planar motion unit can detect in-plane XY motion within a frequency range of 0.001 Hz to 1 MHz with a resolution of better than 10 nm.

The Polytec systems are greatly enhanced by coupling them to a probe station with a complete set of tools for working with MEMS devices. Properly designed probe stations offer control of the test environment and a stable platform to mount the MEMS tools. Thus, a motion analyzer integrated with a quality general purpose probe station equipped with a thermal chuck system can provide a one-stop workstation to test, repair and encapsulate MEMS devices.

# Technologies Unite *for Success*



## MEMS Workstations: Micro-Motion Analysis, Assemble, Test and Repair

### Probe Station Advantages

By combining Polytec's motion analyzer systems with a probe station the user can concentrate on the dynamic test rather than on sample holding, positioning and contact issues already addressed by probe station technology. These solutions were found for the early semiconductor and microbiology applications and are easily adapted to MEMS testing.

Well designed probe stations come with simple sample mounting techniques and sufficient vibration damping of the microscope, sample holder and platen which holds the probes and MEMS tools. Manual stations provide for quick, convenient mounting and testing of wafer pieces, single dies and packaged parts; while semiautomatic stations can automatically step to each selected die on a wafer. A large, stable platen is important as it must hold and move in unison a wide variety of electrical probes and MEMS tools. Micro-tweezers, micro-scalpels,

mini-vacuum wands, optical fiber holders, micro-injection systems, ultrasonic cutters and sample holders are available to test, assemble or repair MEMS devices. In addition, thermal chucks, light and EMI/RFI shields and environmental chambers can provide controlled environments needed to test MEMS functions under a wide range of condition.

## Application Examples

### Accelerometers/Gyroscopes

MEMS accelerometers are quickly replacing conventional accelerometers

for crash air-bag deployment systems in automobiles. MEMS accelerometers are much smaller, more functional, lighter, more reliable, and are produced for 1/10th the cost of the conventional macro-scale accelerometers. Other automotive applications for MEMS include sensors for tire pressure, fuel pressure, air flow, headlight leveling, skid, tilt, shock and vibration to improve efficiency and safety. GPS positioning, navigation sensors and gyroscopes using MEMS technology are already available for use in land vehicles, watercraft and aircraft.

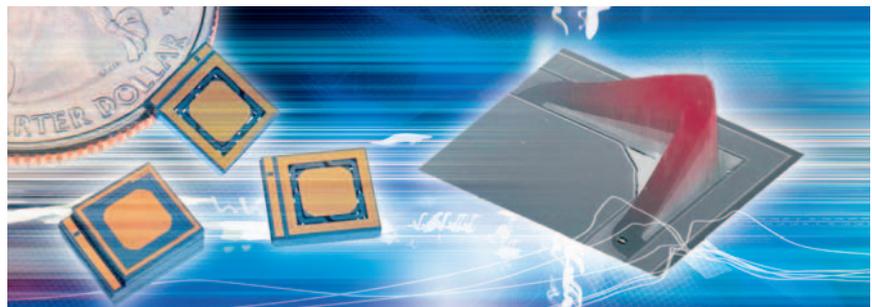
### RF MEMS

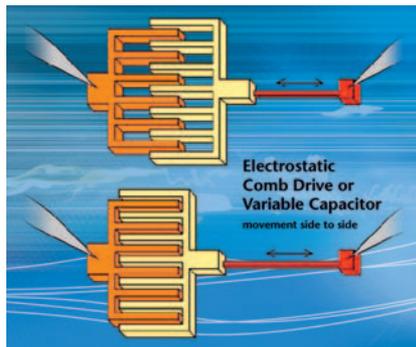
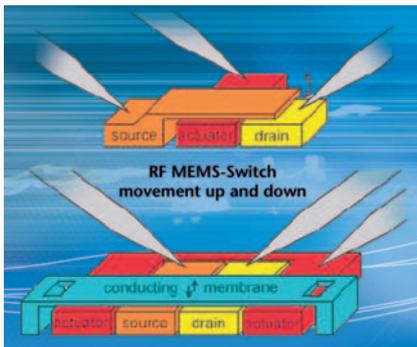
Discrete passives such as RF-switches, variable capacitors, micro-inductors, micro-antennas, high-Q resonators and filters have been identified as components that can be replaced by RF-MEMS equivalents. RF MEMS may be integrated into semiconductor circuits replacing larger discrete components, offer lower power consumption, lower losses, higher linearity and higher Q factors than conventional communications components.

### Example: RF Switch

RF switches open and close electrical contacts by moving a cantilever or membrane up and down to complete an electrical circuit.

Test system requirements may include a Polytec out-of-plane motion analyzer to determine the total displacement of the cantilever or membrane and the speed of switching, and a probe station to provide a clean, controlled atmosphere and the convenience of step-and-repeat testing of switch arrays or die on a wafer. Also this may include a vacuum probe station which can test the switch under





vacuum conditions. The probe station can be equipped with a thermal chuck for bonding experiments, environmental tests and accelerated failure tests; a laser cutter to trim cantilever or membrane materials; micromanipulators to position electrical probes; a micro-syringe system to apply adhesive; and several probes to provide high frequency signals, actuator power, UV-curing light and others.

#### Example: RF Variable Capacitor

Variable capacitors have a number of designs one of which is to use a comb structure which is moved in-and-out to alter the capacitive properties. A similar structure may be used as an electrostatic comb drive to move the variable capacitor parts.

Such structures may be tested by a combining Polytec's in-plane and out-of-plane motion analyzers to determine the total displacement of the comb structure and identify design or manufacturing problems which result in an out-of-plane motion. The probe station may need to be a vacuum probe station which can test MEMS devices under both vacuum or partial pressure and which is similarly equipped to the RF MEMS switch testing setup shown above.

#### Optical Network Components (MOEMS)

Even though the optical network industry recently experienced a major contraction, this industry still uses a wide range of optical MEMS devices. Switches, multiplexers and splitters are some of the MEMS devices which are used in standard optical communication systems.

#### Example: Optical Fiber Switch

Optical fiber switches are used in communication systems to route optical transmissions from one fiber to another. The design shown in Figure XX allows two input and two output ports. The micro-mirror may be moved into position by a comb drive.

System requirements may include a Polytec in-plane and out-of-plane motion analyzer to determine the total displacement of the comb structure, stability of the micro-mirror and identify design or manufacturing problems which result in unexpected out-of-plane motion. The probe station should provide a tilt/tip stage and a large platen to support multiple tools (laser cutters, optical fiber holders, micro-tweezers) to test and assemble the optical switch.

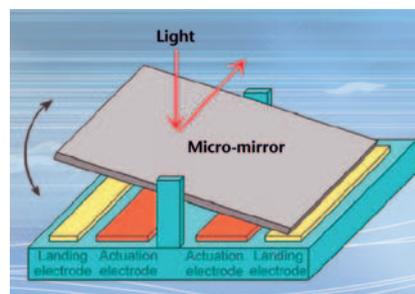
#### Video Displays

Video projection chips with a million moveable micro-mirrors are a significant MEMS application. The ability to independently control each micro-mirror allows for image control not available in traditional optical systems.

#### Micro-Mirrors

Micro-mirrors, activated by capacitive attraction or piezoelectric motion, are an important commercial application for MEMS, as they allow light to be manipulated at the micro-scale for use in micro-scanners and optical switches. Texas Instruments recently produced a capacitive micro-mirror for a Digital Light Processing technique used in new digital cinema projectors.

The combination of Polytec's in-plane and out-of-plane motion analyzers is able to determine the total displacement and stability of the micro-mirror, and identify design or manufacturing problems. The probe station should be equipped similar to the optical fiber switch testing setup described above and should provide multiple tools to test and repair the micro-mirror.



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#### About Micromanipulator

Creating leading edge analytical probe stations and accessories for semiconductor probing professionals has been The Micromanipulator Company's primary focus since 1956, providing solutions for almost every test requirement.  
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