# **NEXLINE**<sup>®</sup>

Linear Piezo Motor Actuator Combining Long Travel, Picometer Resolution and High Forces



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### **The Problem: Moore's Law**

#### transistors





### The Problem: Moore's Law

- Moore's Law compresses IC linewidths and feature-sizes.
- Nanopositioning mechanisms embedded in frontend production and metrology tools have difficulties keeping up; they must provide 10 to 1000x higher precision than feature size.
- Vibrations, position errors, drift need to be controlled to <0.1 nm (~atom diameter).
- Conventional nanopositioning systems have either high accuracy and short travel or do not provide the required stability and precision.



### **Requirements from Semiconductor Industry for Next Generation Actuators**

- Resolution <0.1 nm + travel of several mm</li>
- Keep position stable to nanometer level for a long time
- Lifetime several years minimum
- Stiff with high resonant frequency for fast response and low vibrations
- Must work in Vacuum, Helium, Magnetic Fields

**But How?** 

Requirements can only be met with solid state piezoceramic actuators!



# **Piezo Technology Before NEXLINE®:**

### **Piezo = Mission-critical Technology**

Deployed throughout semiconductor fabrication, packaging & test

#### Actuators

High Force, Speed, Resolution
 NEW: Ceramic Encapsulation (+Lifetime)

### Flexure Positioners/Scanners

- <1 nm Resolution/Trajectory Accuracy</li>
- High-Speed Positioning and Scanning

### Capacitive Position Feedback

Sub-nm Resolution & Stability

Limitations (for some applications):
 Either small travel range
 OR low stiffness
 No position hold with power off



State-of-the-art PICMA® piezo actuators feature protective ceramic encapsulation



Low-profile, parallel-kinematics multi-axis

nanopositioning stage for nanometrology



### **NEXLINE®: Solves the Problem**

 NEXLINE<sup>®</sup> Addresses the Drawbacks of Existing Nanopositioning Systems

### Unique Combination

- Long Travel (No Basic Limitation)
- <0.1 Nanometer Resolution</p>
- High Bandwidth, High Force (to 500 N)
- Very Compact & Stiff
- Vacuum, Helium, UV compatible, Wide Temp. Range
- Non-Magnetic Option (Electron Beam Compatible)
- Auto Lock: nm-position hold @ 0V operating voltage:
  No Leakage Currents => no wear => 10 Year Lifetime





## **NEXLINE® Innovative Linear Actuators**

#### **Piezoelectric Hybrid Drive**

- Flexible
  - Geometry, Size, Force, Travel
- Three Integration Levels
  - OEM Motor, Actuator, Multi-Axis Stage

#### • Applications:

- Nanofabrication
- Lithography
- Alignment and Nanopositioning
- Metrology / Testing
- Repair Systems







### **NEXLINE® Working Principle**

- Combination of Shear and Linear Piezo Actuators
- Flexures for high guiding precision and zero friction
- Smart Digital Controller combines high resolution analog mode and long range step mode
- Compatible with different high resolution sensors







**PI NEXLINE® Nanopositioning Drive** Technology Innovation Showcase (TIS) 2005

### **NEXLINE® Working Principle**

- analog
- step
- mixed
- const. speed







### **NEXLINE<sup>®</sup> – Actuator Characteristics**

### N-215.00

- **Stroke**: 20 mm
- Continuous Analog Mode: Resolution < 0.05 nm Range: to 4 µm
- Step Mode: Step size: 5nm - 8µm
- Blocking force: >500N
- Slipping force: >600N



semi



### **NEXLINE<sup>®</sup> – Actuator Characteristics**

### • A) Long range step mode



11 Piezo · Nano · Positionir

### Value for Semiconductor Industry

- NEXLINE® helps to increase resolution
  of steppers or scanners
- Improves the precision of projection systems by correcting errors caused by by vibrations, mechanical or thermal problems or other deficiencies
- Was specifically developed for the semiconductor industry and combines high resolution, compact design, high force, stiffness and lifetime





## **NEXLINE<sup>®</sup> Systems: What's next?**

- NEXLINE® can be Integrated in Complex Multi-axis Positioning Systems
- Applications:
  - Wafer Chuck: Z/Tip/Tilt Stages
  - Positioning systems for nanoimprint lithography
  - Nanometrology systems





## High Load Z-Tip/Tilt Wafer Stage

- Z-stroke: 1.3 mm
- Tip/Tilt: +/- 4mrad
- Max. Load >50 kg
- Closed loop with internal incremental sensor







### **Nonmagnetic 6-DOF Hexapod**

### Low Profile, Six-Axis Nanopositioning System

- 8" Aperture
- Load 50kg
- Low Profile: 140mm
- Translation XYZ: 10mm
- Rotation all axes: 6 °





# **NEXLINE® Technology Summary**

- Increases performance of production and metrology tools
- Proven, novel technology
- Has been successfully used in semiconductor applications
- Addresses challenges of emerging lithographies (e.g., EUV, immersion, nanoimprint)
- Overcomes limitations of classical nanopositioning systems
- Very flexible: from OEM-actuators to 6 DOF systems





