Midwest MicroDevices

A Pure-Play Foundry For MEMS and Thin-Film Devices

Fabrication Capabilities
Photolithography

MMD’s g-line photolithography toolset is specifically tailored for MEMS production. Our fully automated line is capable of handling opaque, transparent, and semi-transparent substrates, as well as, multiple photoresist processes. A robust, dual-layer resist is used for lift-off processing. Contact, proximity, and stepper alignment and exposure is capable of resolving features as small as 0.7 µm. IR backside alignment is used for double-sided photolithography.

- Positive resist
- Dual-layer lift-off resist
- Thick and double-coat resist (4-22 µm)
- Contact alignment and exposure
- Proximity alignment and exposure
- Stepper alignment and exposure
- Back-side IR alignment and exposure
- SU-8 processing
Sputtering and Evaporation

MMD’s metal and semi-metal deposition capabilities are world-class. Our automated, HMI-controlled, batch sputtering and evaporation systems are able to deposit a wide range of materials. Sputtering capabilities include DC-magnetron sputtering, reactive sputtering, and co-sputtering from 2 target materials. RF bias during deposition, RF back-sputtering, load-lock heating, and heating during deposition are all available options. Evaporation capabilities include metals and semi-metals. Long-throw distance evaporation is used to ensure uniformity and repeatability in deposited films. Lift-off and planetary fixturing and heating, before and during deposition, are available. Our custom, dual-source e-beam evaporation system is capable of depositing homogeneous alloys to within ±2%.

Sputtering
- Aluminum, Aluminum-Silicon
- Titanium
- Titanium Nitride
- Tungsten
- Titanium-Tungsten
- Gold
- Platinum
- Nickel
- Copper
- Molybdenum

Evaporation
- Aluminum
- Titanium
- Chromium
- Nickel
- Gold
- Platinum
- Silver
- Copper
- Silicon
- Germanium
- Antimony
- Bismuth
- Aluminum-Silicon
- Nickel-Chrome
- Gold-Germanium
- Bismuth-Antimony
LPCVD and PECVD

MMD utilizes LPCVD and PECVD processes to deposit dielectric thin films with great precision and uniformity. Our fully automated LPCVD batch furnace tubes are capable of deposition on up to 50 wafers at a time with typical within-wafer uniformity of less than ±3%. PECVD processes are performed in a multi-chamber cluster tool with fully automated robotic handling, upgraded with the capability to handle transparent and semi-transparent substrates.

**LPCVD**
- Polysilicon, undoped
- In-situ doped polysilicon, n-type
- Stress-controlled polysilicon
- Silicon Nitride, stoichiometric
- Silicon Nitride, low-stress
- Silicon Dioxide (DCS/N₂O)
- Silicon Oxynitride
- Oxide/Nitride/Oxide stress balanced stack

**PECVD**
- Silicon Dioxide (TEOS/O₂)
- LTO (TEOS/Ozone)
- Silicon Nitride, stoichiometric
- Silicon Nitride, stress-controlled
- Silicon Oxynitride
- Borosilicate glass (BSG)
- Phosphosilicate glass (PSG)
- Borophosphosilicate glass (BPSG)
Furnace Processing

High-temperature processing is performed in fully-automated horizontal furnaces capable of handling batch sizes of up to 100 wafers at a time. SPC analysis is used to ensure run-to-run repeatability and within-wafer uniformity of less than ±3%. Each furnace tube runs independently on its own microprocessor. Software control allows us the flexibility to match furnace recipes to customer’s needs.

Furnace Processing
- Wet oxidation
- Dry oxidation
- POCl₃ doping, n-type
- Boron doping, p-type
- Deep Boron diffusion
- Metal anneal, N₂
- Metal anneal, forming gas
- Diffusion drive-in
- Ion implantation activation
Etching

Reactive-ion etching, plasma etching, and wet chemical etching are all processes MMD utilizes in the fabrication of MEMS devices. RIE processes are performed in a multi-chamber cluster tool with fully automated robotic handling, upgraded with the capability to handle transparent and semi-transparent substrates. Plasma etching is available for photoresist removal, isotropic dielectric etching, and organic polymer etching. Wet chemical etching of a variety of materials is performed with pre-mixed, stabilized etchants for excellent repeatability and etch control.

**Reactive Ion Etching**
- Silicon dioxide
- Silicon nitride
- Polysilicon, anisotropic
- Polysilicon, isotropic
- Silicon, isotropic
- Silicon, anisotropic
- Aluminum
- Titanium
- Hafnium oxide
- PZT

**Plasma Etching**
- Photoresist removal
- Polymer removal
- Silicon dioxide, isotropic
- BPSG via etch
- Parylene via etch

**Wet Etching**
- Silicon
- Polysilicon
- Silicon dioxide
- Silicon nitride
- Aluminum
- Aluminum/Silicon
- Titanium
- Titanium Nitride
- Chromium
- Gold
- Tungsten
- Titanium/Tungsten
- ITO

**Wet Processing**
- Acid cleaning
- Solvent cleaning
- Metal lift-off
Silicon micromachining is a key aspect of modern MEMS device fabrication. MMD has developed extensive expertise in this area using a wide variety of micromachining methods. An advanced, STS Pegasus DRIE is used for fast, high aspect ratio silicon etching. KOH, TMAH, and EDP etchants are all used for bulk silicon etching and device release. Xenon difluoride is also utilized for fast, isotropic silicon etching and device release.

**Silicon Micromachining**
- DRIE silicon etch
- DRIE through-wafer etch
- SOI handle etch
- AOE, deep oxide etch
- XeF2 etching
- KOH bulk etching
- KOH pre-alignment etching
- EDP etch and release
- TMAH etch and release
Back End Processing

Wafer dicing and full-wafer probing are available after completion of the fabricated MEMS device. MMD has experience dicing a wide range of materials, from silicon to glass to ceramics. In addition, we have strategic relationships with key vendors that allow us to offer laser dicing, laser drilling, and micro-abrasion machining. Fully automatic probing is available with wafer mapping and die-reject inking. Semi-automatic probing with custom probe configurations is also available for exotic and/or unusual testing requirements.

Back End Processing
- Wafer dicing
- Laser dicing
- Laser drilling
- Micro-abrasion
- Wafer probing
- Die inking
- Wafer mapping
Additional Processing

Modern MEMS device production requires more than just traditional silicon wafer processing. Wafer bonding, CMP, and plating are just a few of the additional fabrication processes we offer.

Additional Processing
• Fusion bonding
• Anodic bonding
• Vacuum bonding with gettering
• CMP
• Backgrinding
• Plating
• Spin-on-glass (SOG)
• Flexible film bonding
• PDMS deposition & patterning
• Parylene deposition & patterning
Metrology

At MMD, we take pride in offering our customers repeatable, reliable, MEMS production services. To ensure this level of quality, all of our major fabrication processes are continually monitored through a full set of metrology tools. Process monitors and quality checks are automatically built-in to our production process flows. Consistent quality checks at every major stage of device production is a key to our success.

**Metrology**
- Microscope inspection
- SEM inspection
- Line-width inspection
- Resistivity/sheet resistance
- Mechanical profilometry
- Optical profilometry
- Stress measurement
- Optical interferometry
- Ellipsometry
- IR bond inspection
- EDX, Auger, ESCA material analysis
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