MicroWriter ML®3 Pro

Durham Magneto Optics Ltd

The MicroWriter ML® products are a range of photolithography machines designed for rapid prototyping and small volume manufacturing in R&D laboratories and clean rooms.

Conventional approaches to photolithography are usually based on exposing through a chromium-glass mask manufactured by specialist vendors. In R&D environments it is often necessary to change the mask design frequently. Direct-write lithography tools (also known as digital mask aligners or maskless aligners) overcome this problem by holding the mask in *software*. Rather than projecting light through a physical mask, direct-write lithography uses computer-controlled optics to project the exposure pattern directly onto the photoresist.

MicroWriter ML®3 Pro is our flagship machine and is a compact, high-performance, direct-write optical lithography machine which is designed to offer unprecedented value for money in a small laboratory footprint. Sitting on its own vibration-isolation optical table, its only service requirement is a standard power socket. A temperature-compensated light-excluding enclosure with safety interlock allows it to be used equally well in an open laboratory environment or in a clean room. Easy to use Windows® based software means most exposures can be set up and launched with just a few mouse clicks. Four different minimum feature sizes (0.6µm, 1µm, 2µm and 5µm) can be selected automatically via software. This allows non-critical parts of the exposure to be performed rapidly while retaining high resolution writing for critical parts. An additional 0.4µm minimum feature size is available as an option. The MicroWriter ML®3 Pro features an optical surface profilometer tool and an automated wafer inspection tool for examining fabricated structures. A backside alignment camera for aligning double-polished wafers is available as an option.

Key features and specifications:

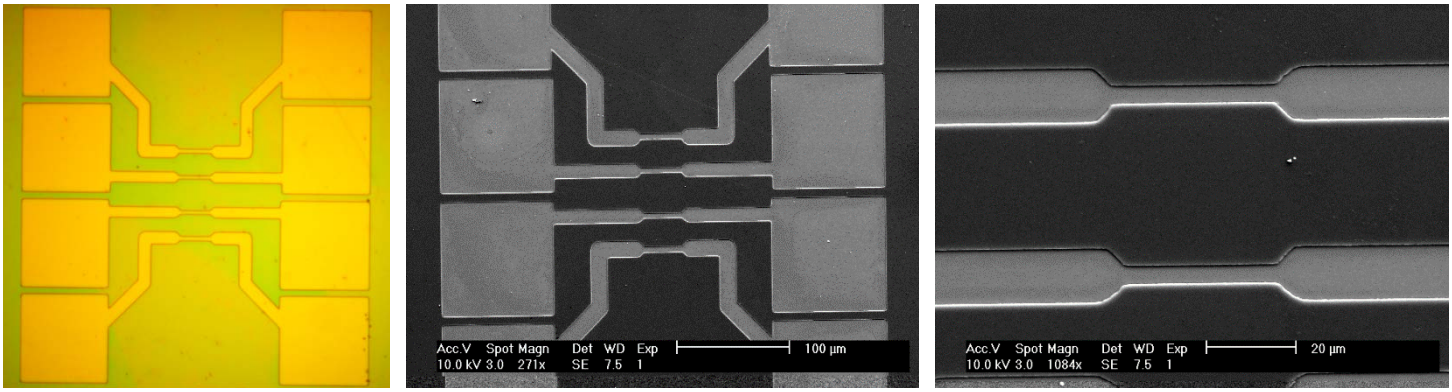
- 195mm x 195mm maximum writing area.
- 230mm x 230mm x 15mm maximum wafer size.
- 0.6µm, 1µm, 2µm and 5µm minimum feature sizes across full writing area. 0.4um minimum feature size available as an option.
- Automatic selection of minimum feature size via software – no manual changing of lens required.
- 385nm long-life semiconductor light source, suitable for broadband, g-, h- and i-line positive and negative photoresists (e.g. S1800, ECI-3000, MiR 701, SU-8). Replacement 365nm lightsource available as option for improved performance with SU-8 photoresist.
- XY interferometer with 1nm resolution for precise motion control.
- Extremely fast writing speed - up to: 17mm^2/minute (0.6µm minimum feature size), 50mm^2/minute (1µm minimum feature size), 120mm^2/minute (2µm minimum feature size) and 180mm^2/minute (5µm minimum feature size). These allow a typical 50mm x 50mm area combining critical and non-critical areas to be exposed in under 30 minutes or a typical 100mm x 100mm area to be exposed at 2µm minimum feature size in under 2 hours.
- Autofocus system using yellow light with real-time surface tracking laser– no minimum wafer size.
- High quality infinite conjugate optical microscope with x3 aspheric objective lens and x5, x10 and x20 Olympus plan achromatic objective lens and yellow light illumination for alignment to lithographic markers on the wafer (±0.5µm 3σ alignment accuracy). x50 Olympus plan achromatic objective lens available as an option.

- Automatic changing between microscope magnifications via software – no manual changing of lens required. Additional x4 digital zoom can be selected in software.
- Grey scale exposure mode for 3-dimensional patterning (255 grey levels).
- Software API for external interfacing and control.
- 100nm minimum addressable grid; 4nm sample stage resolution.
- Acceptable file formats: CIF, GDS2, BMP, TIFF, JPEG, PNG, GIF.
- Automatic laser-based wafer centring tool.
- Built-in 2-dimensional optical surface profiler (100nm thickness resolution) for examining exposed resists, deposited layers, etching and other MEMS process steps.
- Automatic wafer inspection tool allowing each die on a wafer to be imaged.
- Virtual mask aligner mode in which the pattern to be exposed is displayed on top of the real-time microscope image, allowing the machine to be used like a traditional mask aligner.
- Multiple wafer / chip handling, allowing different exposure patterns and alignment coordinates to be supplied for multiple wafers or chips on the chuck. Used for exposing multiple users' samples overnight.
- Includes passive vibration-isolation optical table with integrated monitor and keyboard mount.
- Light-excluding enclosure with safety interlock and temperature compensation to ±0.25°C
- Easy to use, Windows® based control software supplied.
- Supplied with Clewin 5 mask design software.
- Supplied with pre-configured 64-bit Windows® 10 PC with monitor, keyboard and mouse.
- Includes on-site installation by trained service technician.
- Extremely competitively priced for University and industrial R&D budgets.
- 90-260 VAC, 50-60Hz, 4A single phase power requirement.
- Footprint 90cm (w) x 75cm (d); height 153cm (including optical table)
- CE-marked and compliant with EN-61010.

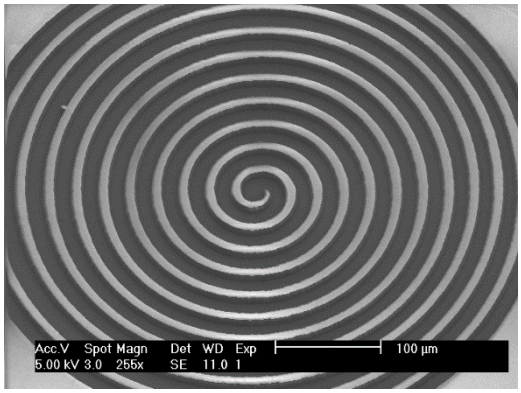
Designed for R&D in:

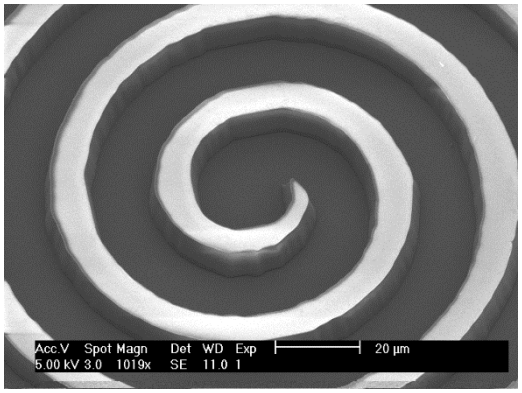
- Microelectronics and semiconductors
- Spintronics
- MEMS / NEMS
- Sensors
- Microfluidics and lab-on-a-chip
- Nanotechnology
- Materials science
- Graphene and other 2-dimensional materials

Examples of fabricated structures

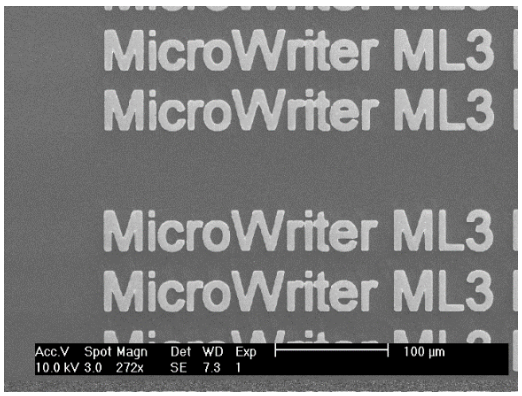


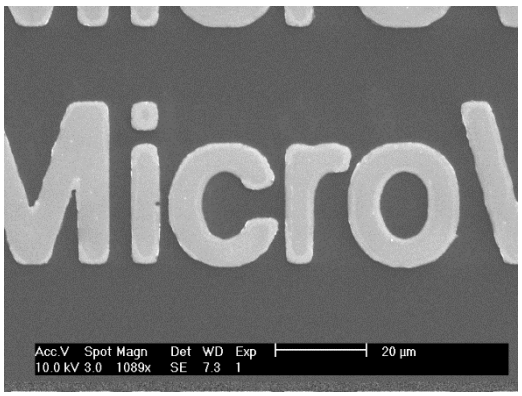
Electrical transport measurement chip: MicroWriter ML®3 Pro built-in optical microscope image of exposed AZ® ECI 3007 positive photoresist (left); SEM images after metallization with 20nm of gold (centre and right). Square contact pads are 100µm wide; central wires are 3µm wide.



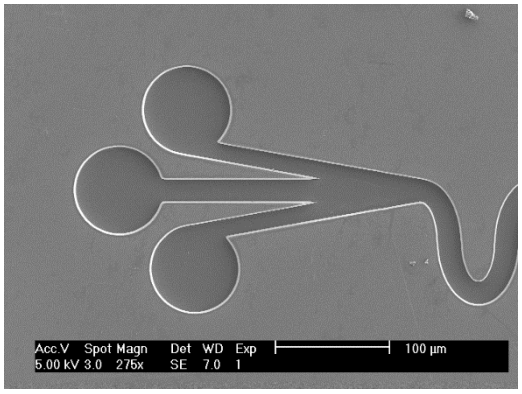


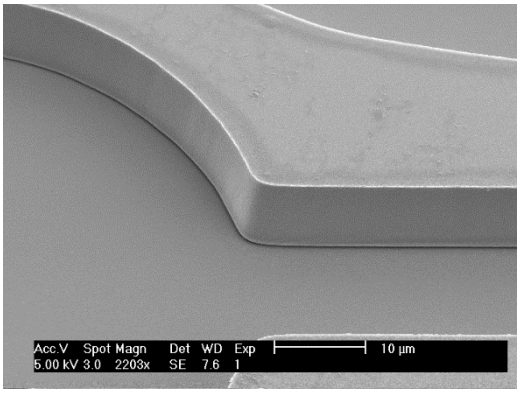
Micro-inductor mold: SEM images after metallization with 20nm of gold of AZ® 9260 12µm thick positive photoresist developed in AZ® 326 MIF developer.



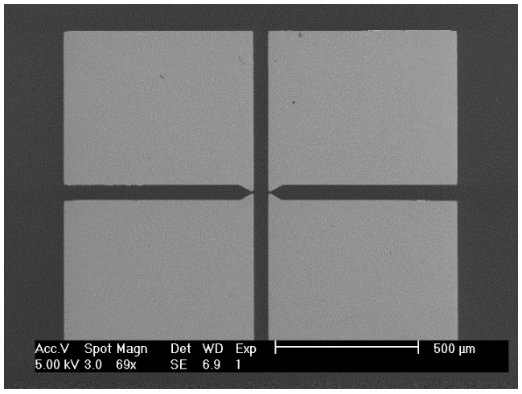


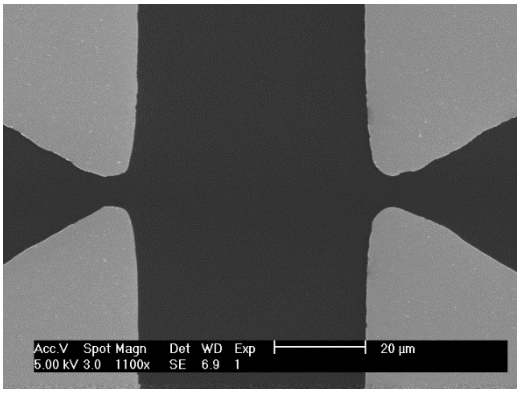
Micro-text: SEM images after metallization with 20nm of gold and lift-off. Lower case letters are 27µm high; gap between letters 'r' and 'o' is 1.5µm.



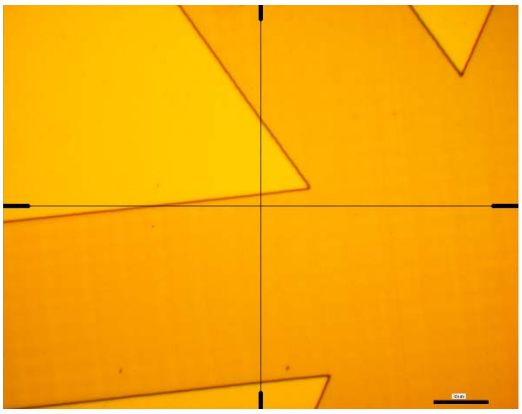


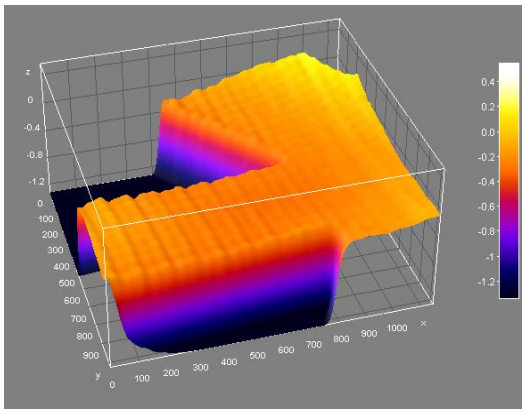
Microfluidic device: SEM images after metallization with 20nm of gold of AZ® 9260 12µm thick positive photoresist developed in AZ® 326 MIF developer.



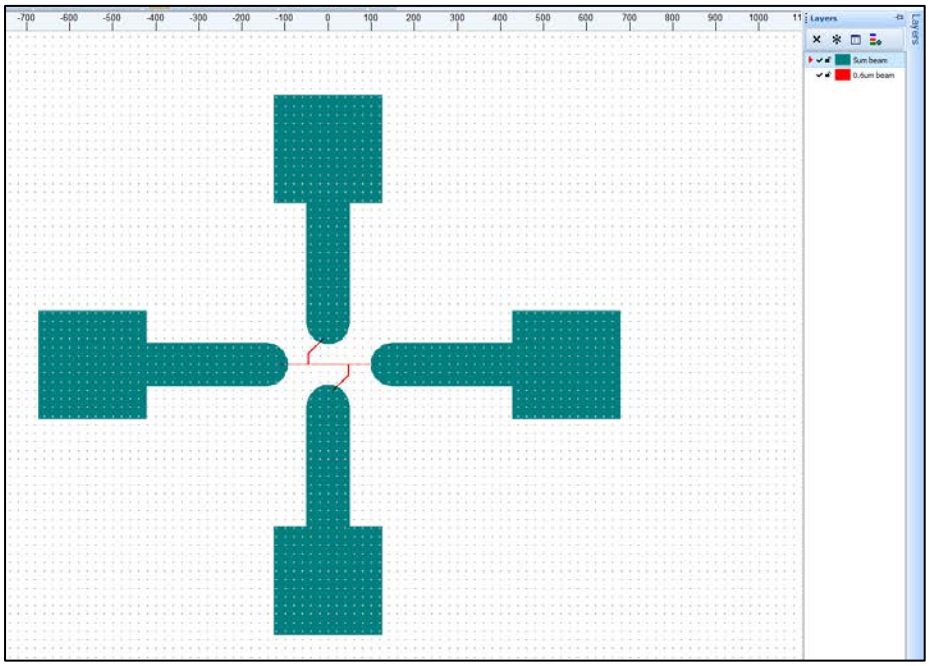


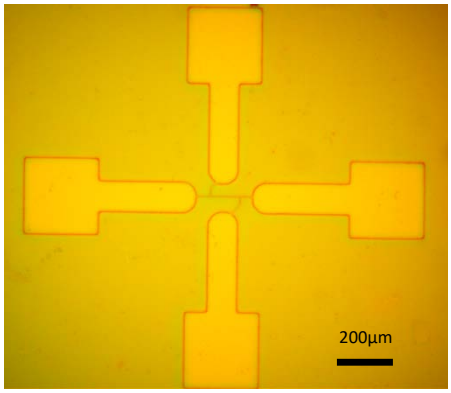
Large area contact pads: SEM image after metallisation with 20nm of gold and lift-off of four 660µm x 540µm contact pads exposed rapidly using 5µm minimum feature size.

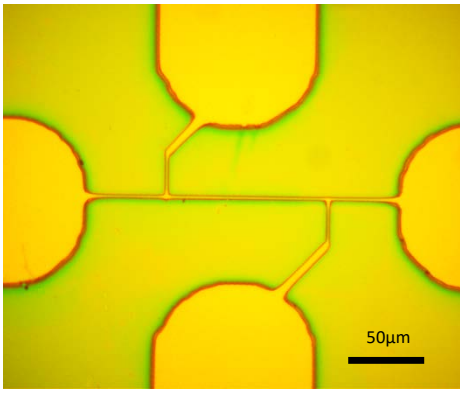




Lithographically patterned 1.4µm thick SU-8. MicroWriter ML®3 Pro built-in optical microscope image (left) and 3D rendered MicroWriter ML®3 Pro optical surface profilometer image (right). Scale bar is 30µm.







Combining different minimum feature sizes.
Top: Clewin 5 mask design layout showing large contact pads and large contact wires on one layer (green) to be exposed with 5µm minimum feature size and connecting fine wires on another layer (red) to be exposed with 0.6µm minimum feature size;
Left: low magnification optical micrograph of resulting exposure in AZ® ECI 3007 0.7µm thick positive photoresist;
Right: high magnification optical micrograph showing the fine wires correctly connected to the large contact wires. The fine wires are 0.8µm wide.

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