

MicroWriter ML[®]3

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 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-stabilised 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 resolutions (0.6 μ m, 1 μ m, 2 μ m and 5 μ m) 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. The MicroWriter ML[®]3 features an optical surface profilometer tool and an automated wafer inspection tool for examining fabricated structures.

Key features and specifications:

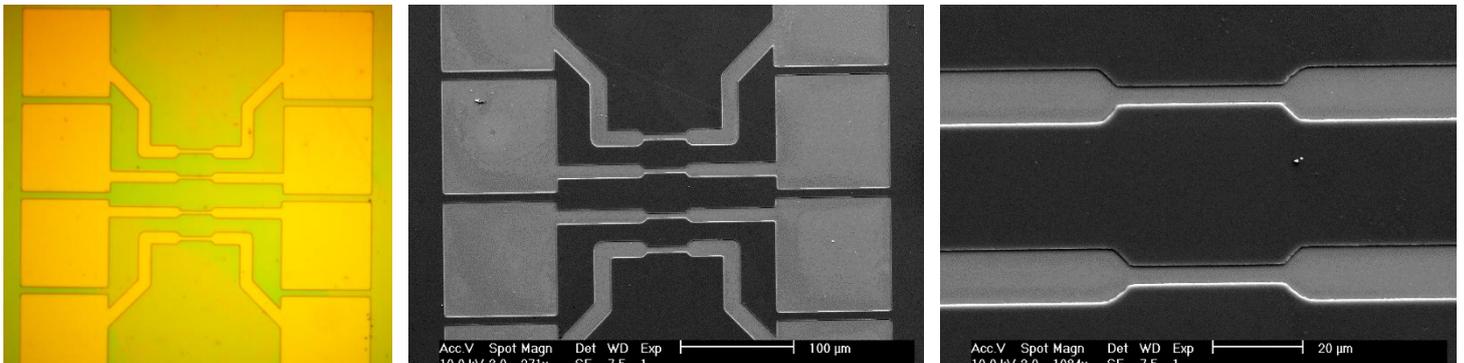
- 195mm x 195mm maximum writing area.
- 230mm x 230mm x 15mm maximum wafer size.
- 0.6 μ m, 1 μ m, 2 μ m and 5 μ m resolutions across full writing area.
- Automatic selection of resolution via software – no manual changing of lens required.
- 385nm long-life semiconductor light source, suitable for broadband, g-, h- and i-line positive and negative photoresists (e.g. S1800, ECI-3000, MiR 701, SU-8).
- XY interferometer for precise motion control.
- Extremely fast writing speed - up to: 20mm²/minute (0.6 μ m resolution), 50mm²/minute (1 μ m resolution), 100mm²/minute (2 μ m resolution) and 180mm²/minute (5 μ m resolution). 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 2 μ m resolution in under 2 hours.
- Autofocus system using yellow light which automatically tracks surface height variation during exposure, compensating for bowed or inclined substrates and surfaces with highly irregular topography. No minimum wafer size.
- High quality infinite conjugate optical microscope camera 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 ($\pm 0.5\mu$ m 3 σ alignment accuracy).
- 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; 20nm sample stage resolution.

- Acceptable file formats: CIF, BMP, TIFF and (via Clewin 5) GDSII.
- 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.
- Includes passive vibration-isolation optical table with integrated monitor and keyboard mount.
- Light-excluding enclosure with safety interlock.
- Temperature stabilisation to $\pm 0.5^{\circ}\text{C}$
- 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.

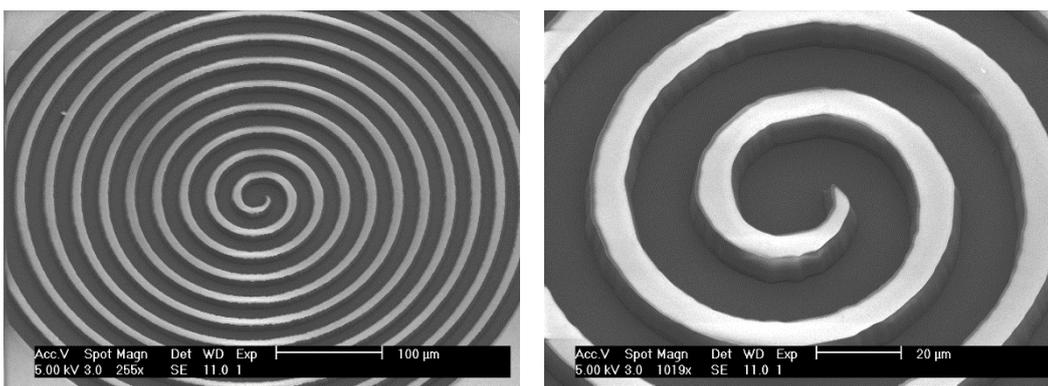
Designed for R&D in:

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

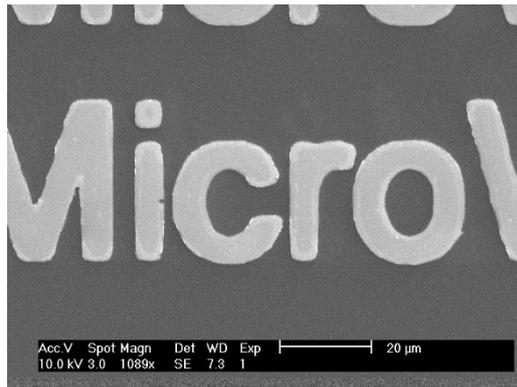
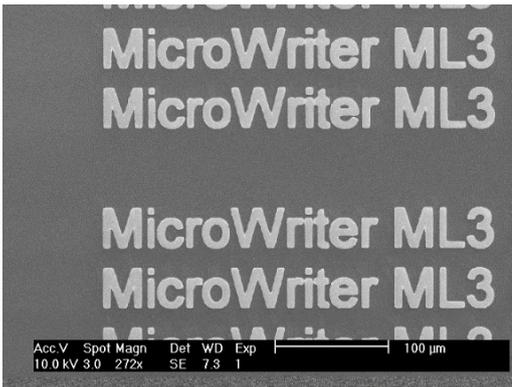
Examples of fabricated structures



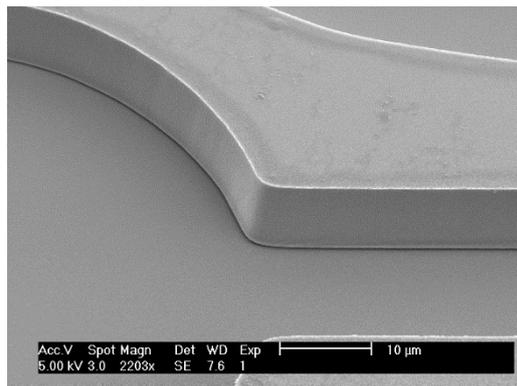
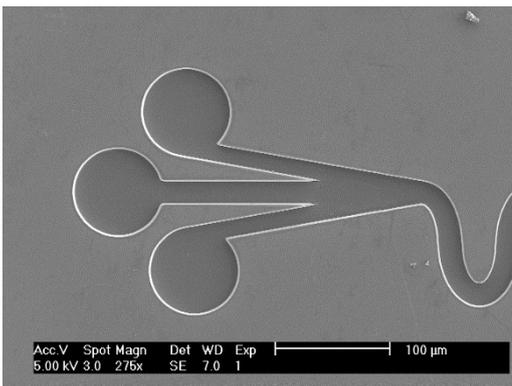
Electrical transport measurement chip: MicroWriter ML[®]3 built-in optical microscope image of exposed AZ[®] ECI 3007 positive photoresist (left); SEM images after metallisation with 20nm of gold (centre and right). Square contact pads are 100 μm wide; central wires are 3 μm wide.



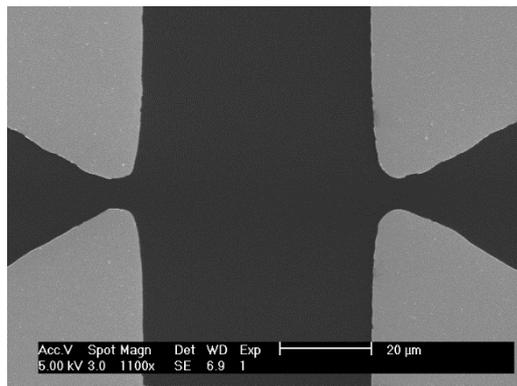
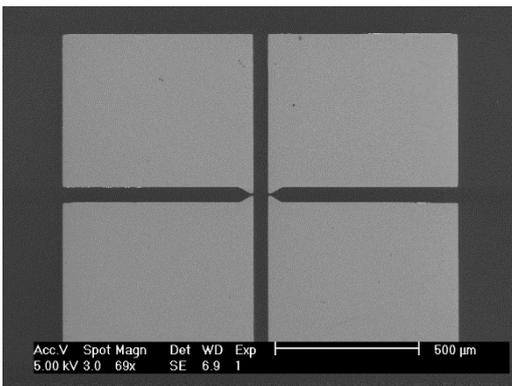
Micro-inductor mold: SEM images after metallisation with 20nm of gold of AZ[®] 9260 12 μm thick positive photoresist developed in AZ[®] 326 MIF developer.



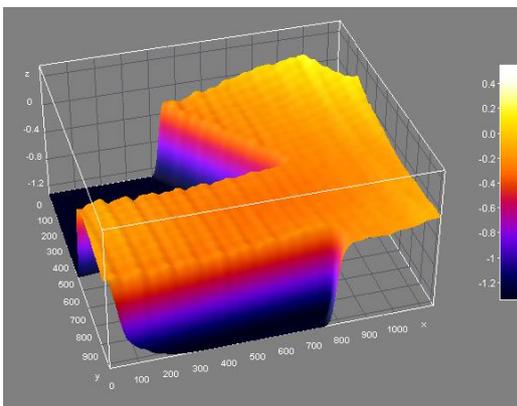
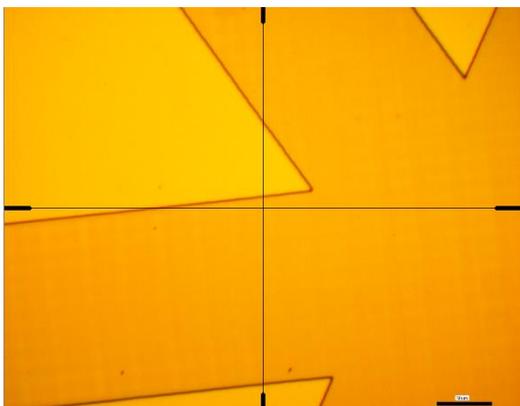
Micro-text: SEM images after metallisation with 20nm of gold and lift-off. Lower case letters are 27 μ m high; gap between letters 'r' and 'o' is 1.5 μ m.



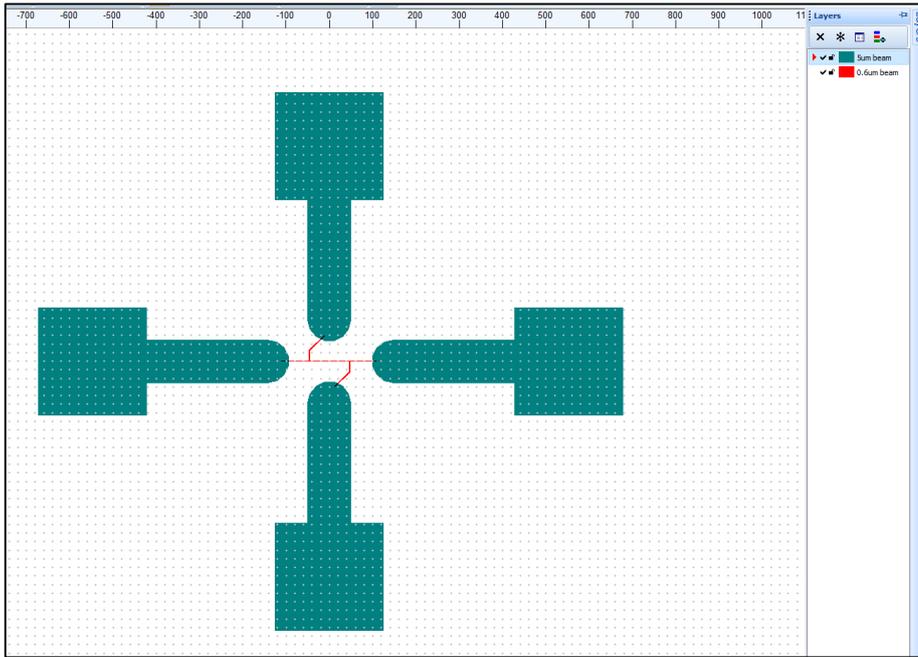
Microfluidic device: SEM images after metallisation with 20nm of gold of AZ[®] 9260 12 μ m thick positive photoresist developed in AZ[®] 326 MIF developer.



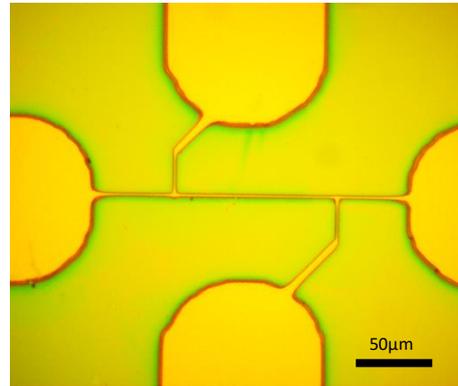
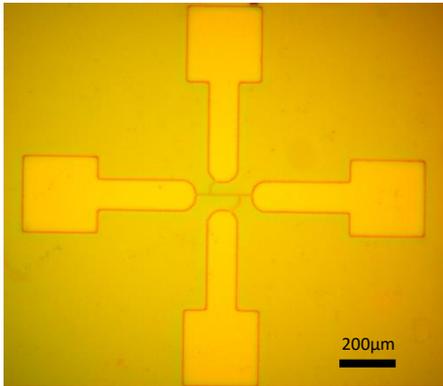
Large area contact pads: SEM image after metallisation with 20nm of gold and lift-off of four 660 μ m x 540 μ m contact pads exposed rapidly using 5 μ m resolution.



Lithographically patterned 1.4 μ m thick SU8. MicroWriter ML[®]3 built-in optical microscope image (left) and 3D rendered MicroWriter ML[®]3 optical surface profilometer image (right). Scale bar is 30 μ m.



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



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