MANCHESTER 1824
The University of Manchester

DIRECT-WRITE OPTICAL LITHOGRAPHY

Overview
Photolithography is one of the key techniques used in the manufacture of prototype electronic devices at the NGI that allow the analysis of the electronic properties of 2D materials.

Traditional photolithography requires the manufacture of a photomask to define each layer of a device. However, with the exfoliation method used at the NGI to produce 2D material flakes, the size and position of a test sample is impossible to predict. Designing and manufacturing a photomask set to then create a test structure of the appropriate size and position would therefore impose significant delays.

The laser-writer removes this obstacle by allowing the device design to be imprinted directly onto a photo-resist coated substrate by scanning with an ultra-violet laser. The laser is controlled by following the design which is encoded into an appropriate data format.

Not only does this remove the delays associated with photomask manufacture but also allows design changes to be made whilst the operator is sitting at the machine, thus introducing flexibility in addition to the considerable time saving.

Capability profile
System: Microtech LW405B

Laser exposure system for direct ‘CAD-to-substrate’ precision patterning.

Mechanical Specifications:
XY stage substrate capability; up to 6in x 6in (150mm x 150mm).
Controlled by linear motors with 10nm positioning resolution.
Positioned monitored by differential XY laser (633nm He-Ne) interferometer with 10nm resolution.

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Maximum overlay error (layer-layer alignment): 0.5µm

Optical Specifications:
Principal exposure source - 405nm GaN solid-state laser, output 60-100mW.
Minimum spot-size selectable via final focussing objective:
0.65NA, 1.0µm; 0.4NA, 2.0µ or 0.25NA, 4.0µm (theoretical minimum line width, 0.6µm).

Associated patterning speeds:
4µm – 40sqmm/min
2µm – 16sqmm/min
1µm – 4sqmm/min

Alternative source: 375nm GaN solid-state laser.
Used with dedicated 0.2NA objective giving a nominal spot size of 5.0µm.
Combination of shorter wavelength and large depth of field (40µm) for optimum performance with thick resist - in particular SU8.

Prototype source:
The NGI system is unique in being fitted with an ultra-deep UV 213nm laser.
Designed to investigate the possibility of patterning nominally electron-beam resists as a complement to the electron-beam exposure systems.
Operates in conjunction with a dedicated CaF2 objective