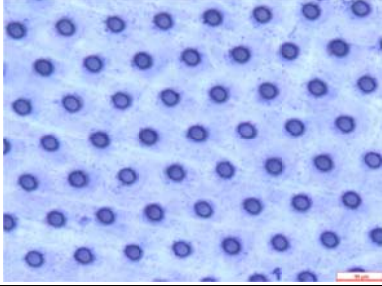
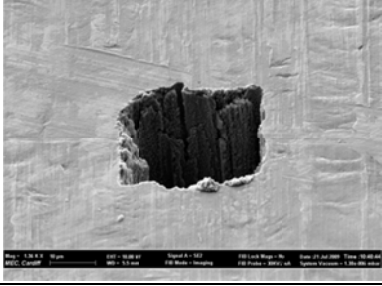
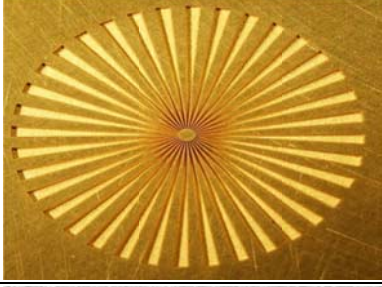
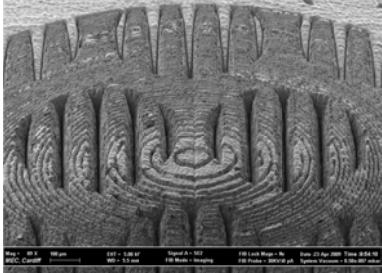


# Micro Nano Patterning

## Laser Material Processing @ Cardiff

Cardiff University, United Kingdom



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<b>Material class:</b>	Silicon X	Polymer X	Metal X	Ceramic X	Glass X	Organic X	Other X
<b>Short technology description:</b>	<ul style="list-style-type: none"> <li>- <b>Micro-second laser</b> <ul style="list-style-type: none"> <li>- 1064 nm wavelength, 10 μs pulse, 50 kHz pulse frequency, 20 W average power</li> <li>- Machining limited to metals and ceramics</li> <li>- Full 3D structures limited only by 2.5 aspect ratio and minimum feature size of about 50 μm</li> </ul> </li> <li>- <b>Nano-second laser</b> <ul style="list-style-type: none"> <li>- 1064 nm wavelength, 15 ns - 220 ns pulse duration, up to 500 kHz pulse frequency</li> <li>- any materials like metals, ceramics, silicon, except polymers</li> <li>- 3D structures with a minimum feature down to 15μm</li> </ul> </li> <li>- <b>Pico-second laser</b> <ul style="list-style-type: none"> <li>- 355 nm and 532 nm wavelength, 12 ps pulse duration, up to 600 kHz pulse frequency</li> <li>- Capable of machining virtually any material</li> <li>- 3D structures with a minimum feature size down to 3 μm</li> </ul> </li> </ul>						
<b>Typical structures and designs:</b>			<b>Ø15μm through holes in Polycarbonate foil</b> <ul style="list-style-type: none"> <li>- 100μm thick</li> <li>- PS laser</li> </ul>				
			<b>Square hole</b> <ul style="list-style-type: none"> <li>- side 20 μm</li> <li>- through 150 μm thick stainless steel foil</li> </ul>				
			<b>Siemens star type structure produced by μs laser</b> <ul style="list-style-type: none"> <li>- diameter 20mm</li> </ul>				
			<b>3D structure on tungsten carbide</b> <ul style="list-style-type: none"> <li>- machined by ps laser</li> </ul>				

<b>Special features:</b>	<ul style="list-style-type: none"> <li>- High resolution live imaging during milling, deposition or etching</li> <li>- Compositional analysis (EDX)</li> <li>- TEM sample preparation tool kit</li> <li>- Scanning transmission electron analysis (STEM)</li> </ul>
<b>Limitations, constraints:</b>	<ul style="list-style-type: none"> <li>- Positional accuracy 0.5 <math>\mu\text{m}</math></li> <li>- Min. feature size 30 nm</li> <li>- Aspect ratio 3:1</li> <li>- Surface roughness 5 nm</li> <li>- Part size app. 100 mm</li> <li>- Removal/deposit rate 0.5 <math>\mu\text{m}^3/\text{s}</math></li> </ul>
<b>Material examples:</b>	<ul style="list-style-type: none"> <li>- Metals, e.g. Ni and Ni-alloys, Ti, Co</li> <li>- Amorphous alloys, e.g. Ni-Si-P-B</li> <li>- Ceramics and glasses, e.g. SiO<sub>2</sub>, CrC, Glassy Carbon, Diamond</li> <li>- Single crystals and materials for nano-electronics, e.g. Si, ZnO, GaAs</li> <li>- Polymers, e.g. PMMA, PTFE</li> </ul>