A laser beam is focused and scanned over the porous substrate to write a user-defined 2D design. The width, depth and quality of the resultant structure depends on the incident laser fluence. Laser powers required can be as small as few mW, even laser pointers can be used. Writing speeds can be as fast as m/s, well-suited for rapid fabrication.

Laser-based direct-write patterning procedure

Step 1. A porous substrate is soaked with a light-sensitive photo-polymer.
Step 2. A laser beam is then scanned over the pre-soaked substrate.
Step 3. Substrate developed in a solvent to wash away any un-polymerised material.

The polymerised barriers created, define the fluidic structures in porous substrate.

The technique relies on the concept of light induced photo-polymerisation and the fluidic flow paths are formed by patterning of photo-polymer barriers that extend throughout the thickness of the porous substrate, and demarcate the fluidic flow regions within the porous substrate.1, 2

Experimental parameters and results:
• Laser - 405 nm c.w.; output powers: 0.3 - 10 mW; scan speed: 0.05 - 10 mm/s
• Corresponding incident laser fluences: 0.373 J/cm² - 2500 J/cm²

Results:
1. Smallest feature size produced - 50 µm
2. Conditions necessary to contain and guide fluids:
   • Barrier-wall size - 60 µm; Channel widths - 80 µm

Semi-quantitative detection of BSA, Glucose and nitrite in water

<table>
<thead>
<tr>
<th>Cellulose</th>
<th>Cellulose</th>
<th>Nitrocellulose</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSA (ng/ml)</td>
<td>Glucose (mg/ml)</td>
<td>Nitrite (mM)</td>
</tr>
<tr>
<td>Sample 1</td>
<td>25.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Sample 2</td>
<td>31.2</td>
<td>12.3</td>
</tr>
<tr>
<td>Sample 3</td>
<td>32.5</td>
<td>15.6</td>
</tr>
<tr>
<td>Control</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Experimental parameters and results:
1. Grids patterned in cellulose and nitrocellulose with laser powers of 70 mW and 1 mW respectively, with a scan speed of 10 mm/s.
2. Simultaneous multiplex detection without any cross-contamination.
3. Results available in ~1 min, well-suited for rapid diagnostic.

Semi-quantitative, multi-analyte detection of glucose and BSA via a lateral flow type device (T-shape)

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Glucose assay</th>
<th>BSA assay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Sample 2</td>
<td>3.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Sample 3</td>
<td>3.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Control</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Experimental parameters and results:
1. T-junction patterned in cellulose with a laser power of 70 mW and a scan speed of 10 mm/s.
2. Simultaneous detection of BSA and glucose on a single fluidic device.
3. Simple, compact, lateral-flow-type device that needs no additional equipment.

Quantitative C-Reactive protein detection via a sandwich ELISA using a multi-well plate like design

<table>
<thead>
<tr>
<th>Relevance</th>
<th>CRP detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>5.2 ng/ml</td>
</tr>
<tr>
<td>Sample 2</td>
<td>5.8 ng/ml</td>
</tr>
<tr>
<td>Sample 3</td>
<td>6.3 ng/ml</td>
</tr>
<tr>
<td>Control</td>
<td>0.0 ng/ml</td>
</tr>
</tbody>
</table>

Experimental parameters and results:
1. Grid patterns created in nitrocellulose with a laser power of 1 mW at 10 mm/s.
2. Calibration curve plotted by measuring the colour intensities for known concentrations can then be used for determining unknowns.
3. Detection limit - 10 ng/mL (similar to micro titre plate based ELISAs).

Conclusions:
We believe that our laser-based technique is an ideal choice for low-cost and mass-scale fabrication of microfluidic devices that can be used for a variety of applications such as clinical diagnostics and analytical chemistry.

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The authors acknowledge the funding received via the Engineering and Physical Sciences Research Council (EPSRC) Grant Nos. EP/J008522/1 and EP/J025454/1.