Supporting Information

Laminar Flow-Based Fiber Fabrication and Encoding via Two-Photon Lithography

Xiaobao Cao[1], Quan Gao[2], Shangkun Li[1], Songtao Hu[3], Jing Wang[4], Peter Fischer[5], Stavros Stavrakis[1]* & Andrew J. deMello[1]*

[1]Institute for Chemical and Bioengineering, ETH Zürich, 8093 Zürich, Switzerland

[2]School of Mechanical Engineering, Northwestern Polytechnical University, 710072 Xian, China

[3]State Key Laboratory of Mechanical System and Vibration, Shanghai Jiao Tong University, 200240 Shanghai, China

[4]Institute of Environmental Engineering, ETH Zurich, 8093 Zurich, Switzerland

[5]Institute of Food Nutrition and Health, ETH Zurich, 8092 Zurich, Switzerland

* E-mail: stavros.stavrakis@chem.ethz.ch; andrew.demello@chem.ethz.ch

Microfluidic chip design

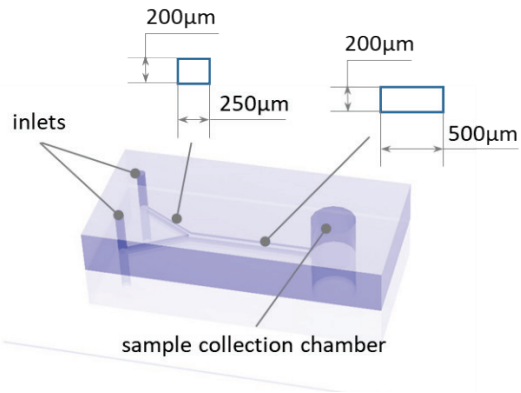

Figure S1. 3D design of the microfluidic chip. Two streams containing the pre-polymer and methacryloxyethyl thiocarbamoyl Rhodamine B-labelled pre-polymer solutions are introduced via the inlets. The large chamber at the outlet is used to collect the printed samples. The cross sections of the inlet and outlet channels are 250 μm × 200 μm and 500 μm × 200 μm (width × height), respectively.

Laser power screening

To achieve the maximum production rate, the laser scanning speed is set at the highest value, 10mm/s. The laser power determines the quality of the printed structures. Low power (< 50 mW) will cause partial or no polymerization, while higher power will increase the size of the cross section of the fibers, producing low resolution structures. Herein, we vary the laser power from 1mW to 100mW with an increase of 1mW for each step defined by each box. The power in mW for each box is set as: ((Colum-1)×10+Row). As shown in **Figure S2** for the fabrication of all microstructures**,** laser power at 60 mW (red labelled) gave the best resolution.

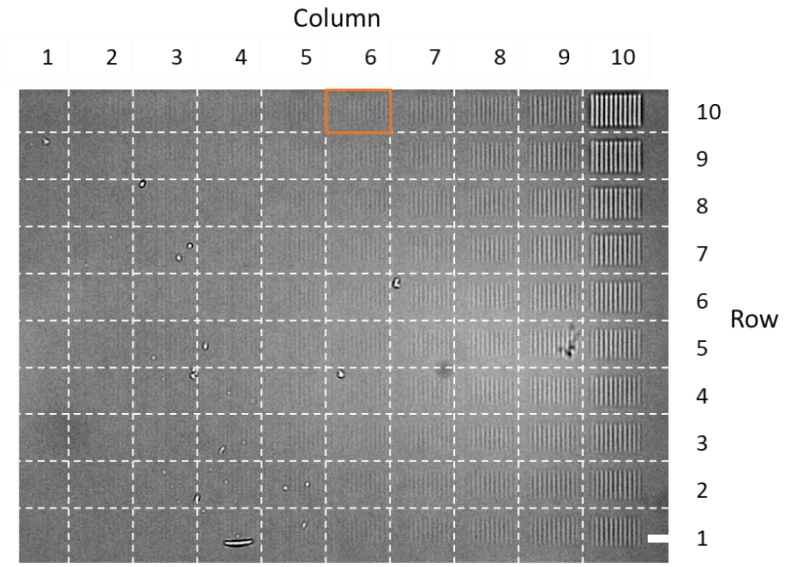

Figure S2. Laser power parameter screening for determining the resolution of the printed structures. Under the scanning speed of 10mm/s, the laser power is set from 1mW to 100 mW. All of 10 microstructures (lines) in each box can be clearly observed at a laser power above 60 mW. Scale bar is 20 μm.

Confocal and brightfield images of the produced microstructures.

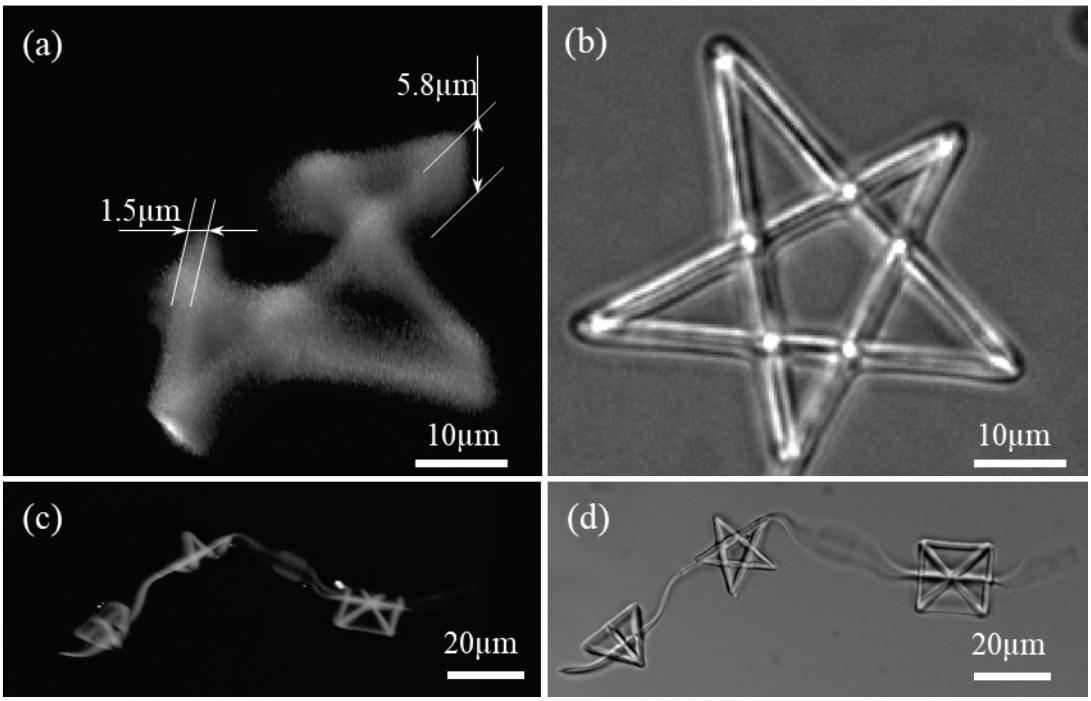

Figure S3. Confocal image (a) of a half fluorescently-labelled pentagram framework and the corresponding brightfield image (b). Confocal image (c) of an encoded fiber and the corresponding brightfield image (d).

Large field of view images of the encoded fibers

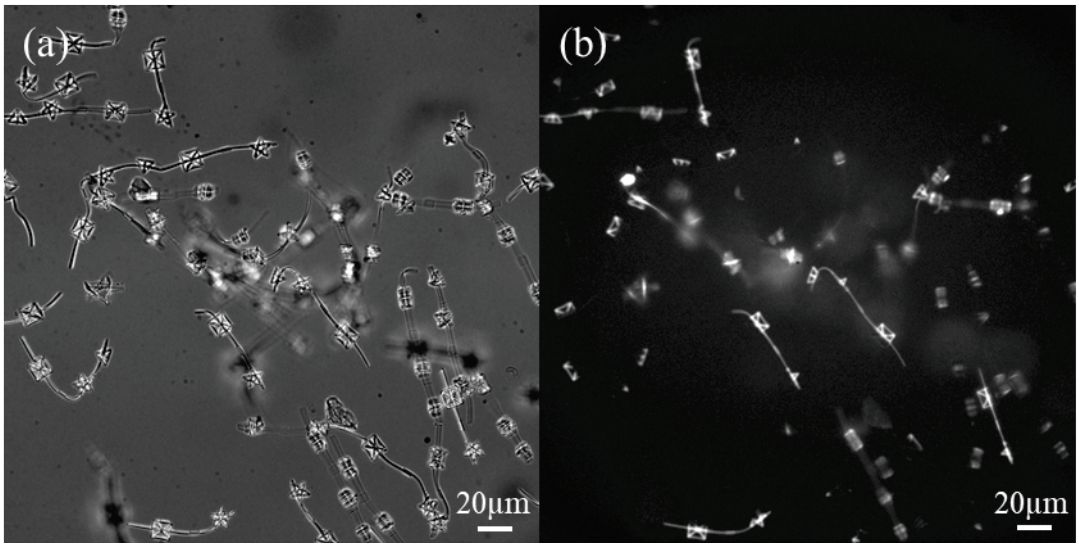

Figure S4. Images of encoded fibers in (a) brightfield and fluorescence (b) mode.

Code for fabricating microstructures using two-photon lithography.

1. Laser power screening

```
InvertZAxis 0
GalvoScanMode
ContinuousMode
PowerScaling 1.0
LaserPower 100
ScanSpeed 10000
var $sumz = 180
var $r = 20
var $x = 0
var $y = 0
var $z = 0
var $powertest=1
var $row = 0

FindInterfaceAt 0.5

for $row = 0 to 9
   for  $powertest = ($row * 10 + 1 to $row * 10 + 10)/100
      LaserPower $powertest
      for $sumz = 0 to 10
         set $x = -$sumz * 3 + 60
         set $y = $r
         $x    $y    $z
         set $x = -$sumz * 3 + 60
         set $y = 0
         $x    $y    $z
         Write
      end
      MoveStageY -30
   end
   MoveStageY 30 * 10
   MoveStageX 40
end
```

2. Particles

```
InvertZAxis 0
% ContinuousMode
GalvoScanMode
ContinuousMode
GalvoSettlingTime 10
PowerScaling 1.0
```

```
LaserPower 60
PowerValuesOn
ScanSpeed 10000
% Triangle frame
var $num = 1
var $numc = 1
for $numc = 1 to 200
   for $num = 1 to 5
      0    0    0
      -5.2627    7.0000    0
      -15.7882    -7.0000    0
      3.6293    -7.0000    0
      -1.6334    0    0
      Write
      -6.8962    7.0000    0
      -7.3164    -7.0000    0
      Write
   end
   Wait 0.2
end

% Rectangle frame
for $numc = 1 to 200
   for $num = 1 to 5
      ScanSpeed 20
      -10    0    0
      -11    0    0
      Write
      LaserPower 60
      ScanSpeed 10000

      0    0    0
      0.500626174321759    10    0
      -18.5469928732973    10    0
      -17.5457405246538    -10    0
      3.50689105429360    -10    0
      4.00751722861536    0    0
      Write
      4.50814340293712    -10    0
      -14.1251103288822    10    0
      Write
      6.92752125006519    10    0
      -11.7057324817541    -10    0
      Write
```

```
        LaserPower 40
        ScanSpeed 400
        10    0    0
        -12    0    0
        Write
    end
    Wait 0.5
end

% Star frame
for $numc = 1 to 30
    for $num = 1 to 5

        LaserPower 60
        ScanSpeed 10000
        0    0    0
        46.7739    0    0
        7.4938    -27.9500    0
        21.3974    17.3500    0
        35.3011    -27.9500    0
        -3.9739    0    0

        Write
        LaserPower 20
        ScanSpeed 20

        0    0    0
        5    0    0
        Write
        end
    Wait 0.2
end
```

3. Segmented fibers

```
InvertZAxis 0
% ContinuousMode
GalvoScanMode
ContinuousMode
GalvoSettlingTime 10
LineNumber 1
LineStartMode 1
PowerScaling 1.0
LaserPower 60
ScanSpeed 10000
```

```
var $sumz = 180
var $r = 10
var $x = 0
var $y = 0
var $z = 0
var $numpillar = 0
var $numfiber = 100
var $numspeed = 0.6
% var $num
var $numpoint = 50
var $totalpoint = 100
var $rfactor = 0.5
var $wavelengh = 20
var $wavelengthfactor = 0.25

set $wavelengh = $totalpoint * 1
var $ffff = 1
for $ffff = 1 to 200
   for $numfiber = 1 to 4
      for $sumz = 0 to 0
         set $rfactor = $numfiber * 0.5 + 1
         for $numpoint = 0 to $totalpoint
            set $wavelengh = $numpoint * $wavelengthfactor + $totalpoint *
$wavelengthfactor * ($numfiber - 1) * 2
            set $x = -$wavelengh + 100
            set $y = sin($numpoint / $totalpoint * 1 * 3.14) * $r * $rfactor
            $x    $y    $z
         end
         set $rfactor = 1
         for $numpoint = 0 to $totalpoint
            set $wavelengh = $numpoint * $wavelengthfactor
            set $x = -$wavelengh +100 - $totalpoint * $wavelengthfactor *
(($numfiber - 1) * 2 + 1)
            set $y = -sin($numpoint / $totalpoint * 1 * 3.14) * $r * $rfactor
            $x    $y    $z
         end
         Write
      end

   end
   Wait 0.5
```

```
end
%
```

4. Multicomponent functional fibres

```
InvertZAxis 0
GalvoScanMode
ContinuousMode
GalvoSettlingTime 10

PowerScaling 1.0
LaserPower 100
PowerValuesOn
ScanSpeed 10000

var $num = 1
var $numc = 1
for $numc = 1 to 200
   for $num = 1 to 5
      LaserPower 40
      ScanSpeed 20
      -10    0    0
      -11    0    0
      Write
      LaserPower 60
      ScanSpeed 10000
      0    0    0
      0.500626174321759    10    0
      -18.5469928732973    10    0
      -17.5457405246538    -10    0
      3.50689105429360    -10    0
      4.00751722861536    0    0
      Write
      4.50814340293712    -10    0
      -14.1251103288822    10    0
      Write
      6.92752125006519    10    0
      -11.7057324817541    -10    0
      Write
      LaserPower 40
      ScanSpeed 400
      10    0    0
      -12    0    0
      Write
   end
```

```
    Wait 0.5
end
```