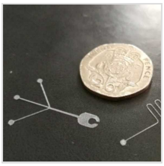

Feb 03, 2021

Open Source Microfluidic Scaffolds

Harry Felton[1], Robert Hughes[1]
[1]University of Bristol

1 Works for me dx.doi.org/10.17504/protocols.io.biw7kfhn

Harry Felton

THIS PROTOCOL ACCOMPANIES THE FOLLOWING PUBLICATION

TBC

DOI
dx.doi.org/10.17504/protocols.io.biw7kfhn

PROTOCOL CITATION

Harry Felton, Robert Hughes 2021. Open Source Microfluidic Scaffolds. **protocols.io**
https://dx.doi.org/10.17504/protocols.io.biw7kfhn

MANUSCRIPT CITATION please remember to cite the following publication along with this protocol

TBC

KEYWORDS
Microfluids, 3D-Printing, Additive Manufacturing, Microfluidics

CREATED
Jul 23, 2020

LAST MODIFIED
Feb 03, 2021

PROTOCOL INTEGER ID
39615

GUIDELINES

There are no particular guidelines for this work.

SAFETY WARNINGS

There are no particular safety guideliens required for this work. However, the following basic guidelines should be followed:

- MEX/FDM 3D printers should only be sued in well ventilated spaces and/or with a suitable filter
- Care should be taken when working with hot surfaces, with adequate signage warning a surface is hot if not immediately obvious
- Care should be taken whilst using sharp tools

DISCLAIMER:

There is no guarantee that the techniques or procedures outlined in this document will work as intended for the user. Users should ensure they have undertaken their own, independent risk assessment before undertaking the work detailed within this document. The author's may not be found liable for any loss of life, effect of health, damage or loss of wealth that may be incurred by following this protocol.

The authors have no responsibility to ensure access to any of the documents or tools described within this document and are not responsible for any loss associated with this.

BEFORE STARTING

To produce a full microfluid mould, the user will need:

- Computer/Laptop (Windows or MacOS based)
- An internet connection
- MEX/FDM 3D printer with suitable material (PLA recommended)
- Hot plate/oven - capable of reaching 200 °C
- Glass microscope slides (x2)
- Tweezers/tongs/oven gloves
- Scalpel (or similar)

Further equipment and material will be needed for PDMS casting (not discussed within this document).

Design

1 User designs the required microfluid system from the sub-systems available.

Generate Models

2 Download, install and open Fusion 360.

NB: Although Fusion 360 works on iOS and Android devices the add-in will not and so a Windows or MacOS device should be used.

Fusion 360
Windows/MacOS/iOS/Android
by Autodesk

3 Load the µ-fluid add-in into Fusion 360

3.1 Download the µ-fluid add-in as a zip file from GitHub (https://github.com/dmf-lab/microfluidics)

3.2 Extract zip file to suitable location on your PC/Mac.

Citation: Harry Felton, Robert Hughes (02/03/2021). Open Source Microfluidic Scaffolds. https://dx.doi.org/10.17504/protocols.io.biw7kfhn

3.3 Within Autodesk Fusion 360 go to:

"TOOLS -> ADD-INS -> Scripts and Add-Ins... -> Add-Ins" and click on the little "+" icon next to "My Add-Ins". Select the folder "Fusion Add-In" contained within the folder from the previous step.

4 Run the µ-fluid add-in. This will be shown in the "TOOLS" and "SOLID" toolbars.

5 Choose module, set parameters and joints.

You will have the option to "Export to stl" - this will export the generated model as an stl file (needed for printing) to a folder of the user's choice. The folder selection menu will appear after pressing "Ok".

6 Do you need more models? If so, **go to step #4** . If not, continue.

Slice Model(s) For Printing

7 Download, install and open Ultimaker Cura. Make sure to follow the correct set-up for your printer.

Cura 4.3+
Windows/MacOS
by Ultimaker

8 Within Ultimaker Cura, open the model(s) generated previously. ("File -> Open File(s)...")

9 Change the profile as appropriate.

NB: This will only work using the downloadable profiles when using Cura for an Ultimaker 3/3 Extended. If you would like to use a different printer, please open the appropriate profile and copy the relevant settings. This should give you a good starting point for printing the scaffolds.

9.1 The µ-fluid channel profiles can be downloaded from github: (https://github.com/dmf-lab/microfluidics). The profiles are contained within the "Cura Profiles" folder (within the Microfluidics zip).

MicroChannels01.curaprofile - Intended for use with 0.1mm nozzle.
MicroChannels04.curaprofile - Intended for use with 0.4mm nozzle.

10 Slice models on buildplate within Ultimaker Cura.

Citation: Harry Felton, Robert Hughes (02/03/2021). Open Source Microfluidic Scaffolds. https://dx.doi.org/10.17504/protocols.io.biw7kfhn

11 Save gcode to file and/or send gcode to printer.

Printing

12 Print models as you would a normal 3D print with the equipment available to you.

13 Once the print is completed, remove the models from the build plate.

> *We found the best way to do this was using a stanley knife (or similar) and prising the connectors of the build plate. The channels are very delicate so this takes some practice and patience.*

Thermal Bonding to Glass 8m

14 Mount the 3D-printed microfluid channel modules onto 1 mm thick glass microscope slides in the desired configuration using the ball-and-socket-connectors. 1m

15 Place a second 1mm thick glass slide on top of the channel configuration to act as a weighting slide 30s

16 Heat the slide-channel-slide assembly at 200 °C for 45-60s to bond the PLA thermoplastic to the glass substrate and smooth out inconsistencies. This is best performed on a temprature controlled hot plate, but heating could also be achieved in an oven or over a flame, however timings and cosistency will vary. 1m

> CAUTION: Hot surfaces and heated assemblies can cause severse burns.

> NOTE: Heating times will vary depending on the height of the 3D-printed scaffold.

17 After heating, use tweerzers, tongs or oven gloves to transfer the thermally bonded slides onto a metal cooling plate (weighting slide down), and leave for 5 minutes. 5m

18 After cooling, slide a blade between the substrate and weighting slides and gently twist to remove the weighting slide. 30s

> NOTE: If the channel scaffolds disbond slightly from the subrate during this step, they can be easily rebonded by breifly reheating the substrate slide at 200 deg C without the weighting slide.

Citation: Harry Felton, Robert Hughes (02/03/2021). Open Source Microfluidic Scaffolds. https://dx.doi.org/10.17504/protocols.io.biw7kfhn

PDMS Fabrication

19 Use the resulting thermally bonded channel design on the substrate slide as the master mould for PDMS casting. See work by Lake *et al.* for a more detailed explanation of this step (https://doi.org/10.1038/protex.2015.069).

Citation: Harry Felton, Robert Hughes (02/03/2021). Open Source Microfluidic Scaffolds. https://dx.doi.org/10.17504/protocols.io.biw7kfhn