Electronic Supplementary Material (ESI) for Lab on a Chip.


# Supporting Information for *Lab on a Chip*

## A 2.5-D Glass Micromodel for Investigation of Multi-phase Flow in Porous Media

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### 1. The 2-D Blueprint and the 2.5-D Micromodel

As shown in Fig.S1(left), regularly positioned pore-bodies are drawn on a 2-D blueprint. On the blueprint, a pore body is combined by a circular main body and four rectangular edges. Neighboring pore bodies are not connected on the blueprint. The pore bodies here are the regions which are exposed to UV light, as well firstly contacted to HF. Fig.S1(right) shows the grain edge shape after HF-etching. The designed etching depth is 23 μm, similar to the horizontal etching distance at the top plane. The horizontal etching direction is shown as red arrow in the figure. After etching, the neighboring pore-bodies get connected from the top, while still un-connected at the bottom plane. As a result, the shape of un-etched volume becomes "jagged" circles at the top, as shown in all optical images in the main text.

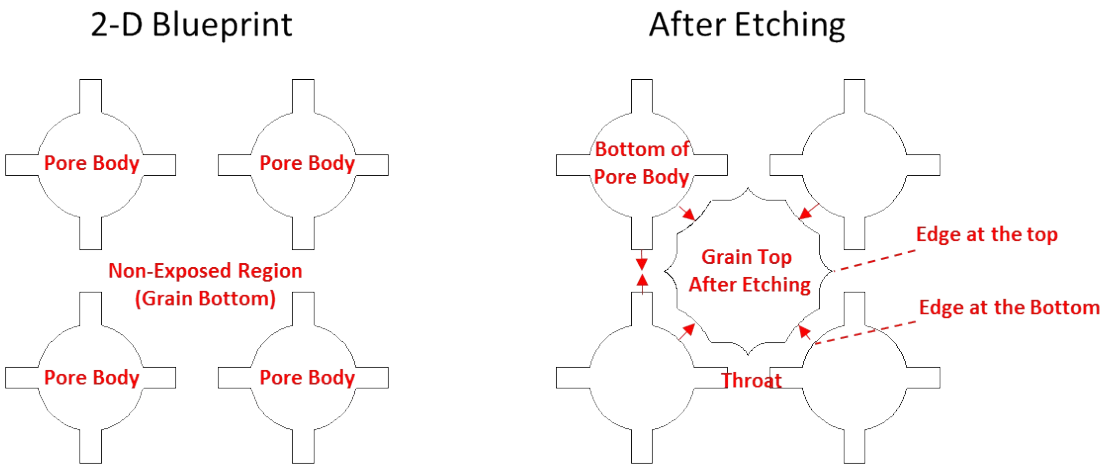


**Fig. S1** Pore and Grain shape in 2-D blue print and after HF etching. left) The 2-D blueprint of the porous media, where the pore bodies are designed as a circular main body and four ledges, not connected with neighbouring pore bodies. right) 2.5-D geometry after isotropic HF etching. The neighbouring pore bodies get connected from the top, leaving a jagged grain shape at the top plane.

On a profilometer platform, the 3-D structure of the 2.5-D micromodel could be clearly identified from a non-vertical view, as shown in Fig.S2. Grains, pore-bodies and throats are consistent as our design, as shown in Fig.S1.

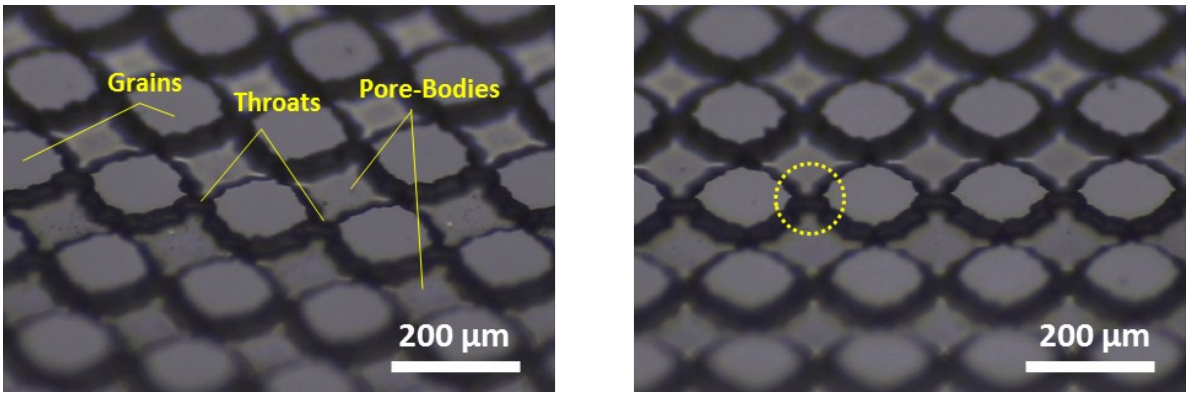


**Fig. S2** Optical images of 2.5-D micromodel, before sealing and from non-vertical viewing angle. Images are taken under a profilemeter. left) Grains, throats and pore-bodies are indicated, and non-vertical pore edges could be observed . right) A throat is circled, where there is actually a "wall" or "dam", which is a barrier between two pore bodies, as well as a bridge between neighbouring grain edges.

## 2. Cleaning Procedure of the 2.5D Micromodel

### 2.1. Cleaning after HF etching

The micromodel cleaning procedure is quite challenging to accomplish, especially in such 2.5D micromodels where the channel connecting neighboring pore-bodies are not flat. Thus, a standard procedure has been established for cleaning:

a. Immerse the micromodel in copper etchant to clean residual copper film and particles.
b. Repeatedly wipe the porous medium with cotton swabs in soapy water. Note: the glass would hardly be damaged under strong wiping due to its hardness and the buffer of cotton.
c. Use DI water to clean the cotton fibers attached on the micromodel. To ensure, repeatedly check the porous medium under microscopy.
d. Flush the micromodel with acetone, in order to remove the organic contamination attached in previous operations.
e. Repeat step b- d on the cover glass chip. Make sure that the bonding side is clean.
f. Wet the micromodel with acetone, and rapidly attach the glass cover. Press the two pieces strongly to force as much acetone out from the gap between two chips, until the two pieces are too close to detach.
g. Heat the two attached glass chips to about 60°C until all acetone evaporates. Check again under microscope for the cleanness. Minor organic contamination is acceptable because it could be removed in the following high-temperature sealing (up to 690°C). However, inorganic contamination should be removed by repeating a-f again.

### 2.2. Cleaning after one experiment and before another

The micromodel must be cleaned in between flow experiments. The operation follows standard steps: (1)flood the micromodel with light oil (C6-C10) for 3PV at 100ul/hr;(2) flood the micromodel with DI water for 3PV at 100ul/hr (3)flood the micromodel with ethanol, till no oil-water interface being observed; (4) flood with DI water again for 3PV at 100ul/hr;(5)dry the chip by heating in 120 °C for 2 hours.