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

# Bubble-particle dynamics in multiphase flow of capillary foams in a porous micromodel

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## Content

File Name: Video S1
Description: **Three stages of foam flow through the microporous environment.**
Three sequences show different states of the foam flowing through the device. Not real speed (slowed down).

File Name: Video S2
Description: **Partial and full clogging remediation**
Foam flowing through a partially clogged micromodel. Full clogging is remediated through pressure build up that forces displacement of bubbles and particles clogging the micromodel. Not real speed (slowed down).

File Name: Video S3
Description: **Water erosion process.**
A current of water sweeps away particles and bubbles trapped in the pores of the micromodel and opens new channels for foam flow. Not real speed (slowed down).

File Name: Video S4
Description: **Flow path reconfiguration.**
Path switching occurs as new flow paths open and the existing paths close. Not real speed (slowed down).

# 1. Experimental set-up

To monitor and quantify the capillary foam's behavior through the microporous environment, the microfluidic device was set under a dissecting scope coupled to a high-speed acquisition camera (Phantom v7, 4000 fps). A syringe pump positioned vertically actuated a syringe loaded with the capillary foam. The foam is transported to the device via PE tubing and, after the device, is collected in a glass beaker.

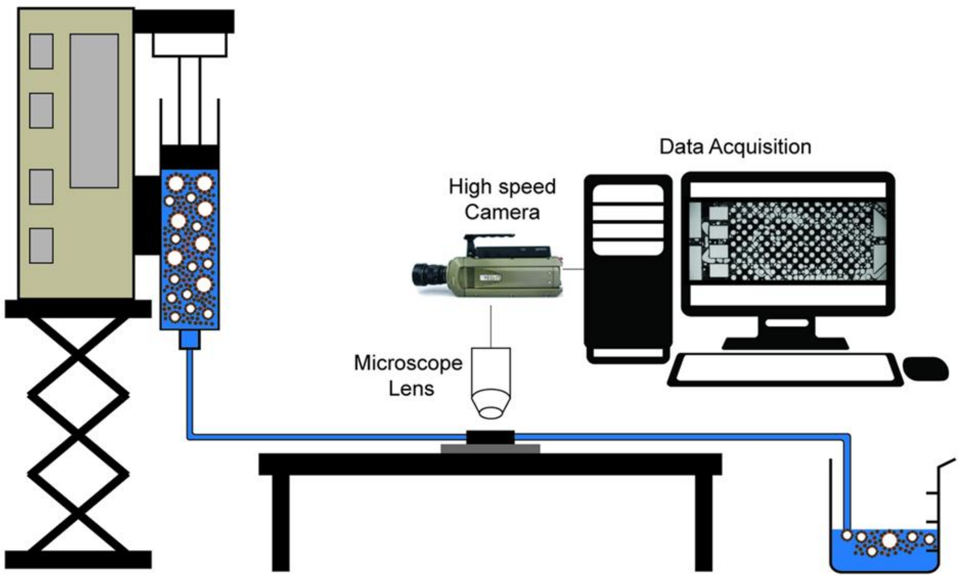


Fig. S1: Apparatus and set-up used to image capillary foam flow.

## 2. Phase separation through PE tubing

At low flow rate, the stress imposed appears to hasten CF aging, leading to CF loss over time. SI Figure 2 shows phase separation as evidenced by the segregated regions of gas plugs, water, and foams in the tube.

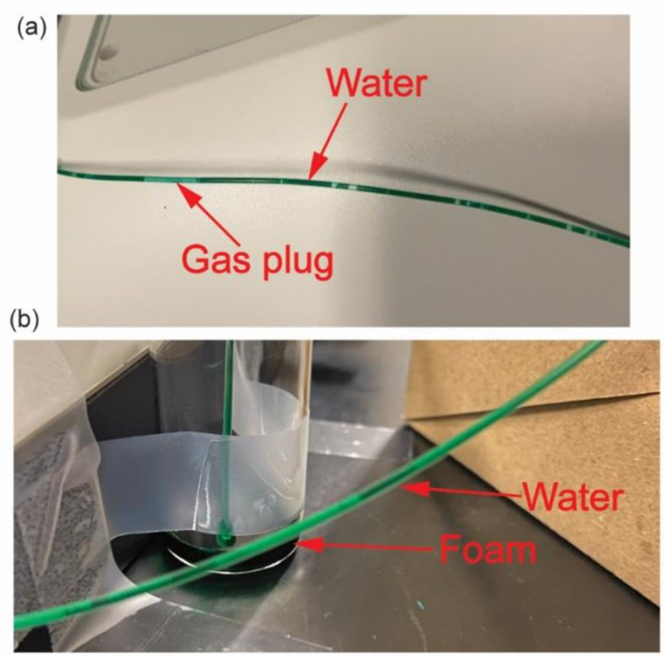


Fig. S2: Images of capillary foams dyed with green food dye flowing through a polyethylene tube showing phase separation between (a) water and gas, (b) foam and water before entering the micromodel.

## 3. Permeability computation

Permeability ($k$) of the porous micromodel used in this work was calculated via the Kozeny-Carman equation in eq. S1 below:

$$k = \Phi^2 \frac{\varepsilon^3 d_p^2}{150 * (1-\varepsilon)^2} \qquad \text{S1}$$

Where, $d_p = 200\mu m$ is the diameter of the constriction, $\varepsilon = 0.65$ is the porosity of the micromodel and $\Phi$ is the constriction sphericity factor; for a circular constriction, $\Phi = 0.87$.