Supplementary Material (ESI) for Lab on a Chip

Supplementary Data

Fabrication of an array microstrainer

A two-layer process was used to fabricate the microstrainer array. A 10-μm thick 1002F film was fabricated first as the base for the strainer. The structure was composed of a 10-μm thick grid within 40-μm square openings. Then a 150-μm thick 1002F film was coated on the top of the base, and holes of a variety of sizes (40-150 μm in diameter) were fabricated in the top layer. After fabrication, the film composed of an array of microstrainers firmly adhered to the glass substrate used in manufacture. By soaking in a soap solution for 16 h, the film could be detached from the glass as a freestanding structure. The detached film remained highly transparent. Figures S1B-S1E show SEM images of the microstrainer when viewed from top and bottom. The lower grid layer was designed to permit liquid to flow through the openings but block the crypts but block the crypts from transiting through the upper layer with circular holes.

Figure S1A shows a detailed schematic of the fabrication process to create an array of microstrainers. A 1002F film of 10-μm thickness was spin-coated on a clean glass slide at 2000 rpm using 1002F photoresist (formulation 10) (Fig. S1A-ii). After baking at 95 °C for 10 min, the film was exposed to UV light at a dose of 1000 mJ/cm^2 (Fig. S1A-iii). The post-exposure baking was performed in a 95 °C oven for 5 min followed by a 120 °C hotplate for 5 min. The sample was then developed for 45 s, and baked on a 120 °C hotplate for 60 min (Fig. S1A-iv). To prevent trapping of air bubbles during the second layer coating step, the sample was treated with air plasma for 5 min to make its surface hydrophilic. A second 1002F layer of 150-μm thickness was spin-coated at 1500 rpm using 1002F photoresist formulation 100 (Fig. S1A-v),

baked at 95 °C for 60 min, exposed to UV light at a dose of 1000 mJ/cm^2 (Fig. S1A-vi), post-exposure baked at 95 °C for 10 min, and then developed for 15 min (Fig. S1A-vii). The film was solidified by baking it on a 120 °C hotplate for 60 min. Finally, the sample was soaked in a soap solution overnight to facilitate release of the freestanding film from the glass slide (Fig. S1A-viii). A 20 × 20 array of capture sites was used for all experiments.

Modeling of the fluid velocity distribution

The velocity field to which the crypt surrogates were subjected as they settled on the array under the influence of gravity flow was modeled using COMSOL Multiphysics 3.4 (COMSOL, Inc., Burlington, MA). A 1 mm column of PBS buffer was considered with a pressure from the top acting as the driving force for liquid flow through a 70 μm diameter circular opening at the bottom. The pressure was calculated as the sum of the atmospheric pressure (1.01325×10^5 N/m^2) and the pressure of 29 mm tall buffer column to closely approximate the experimental conditions. The density of the PBS was assumed to be 1×10^3 kg/m^3 and the viscosity 1×10^{-3} Pa·s at a room temperature of 25 $^{\circ}$C. Incompressible Navier-Stokes (ns) application mode was employed to solve the COMSOL model in 2D.

Figure Captions

Fig. S1 Microstrainer array. (A) Schematic of the fabrication process for the microstrainer. (B) and (C) are views of the top face of the microstrainer array, and (D) and (E) are views of the bottom face. The diameter of the openings is 160 μm.

Fig. S2 Loading surrogates or colon crypts on the microstrainer. Loading of (A) surrogates (with debris) and (B) colon crypts (with debris) on a microstrainer array (diameter of opening = 110 μm).

Fig. S3 2D fluid velocity distribution using COMSOL modeling: (A) in the absence of crypt surrogates, and (B) as the crypt surrogates settle onto the bottom of the array. The micromesh is composed of 70 μm holes spaced at a distance of 210 μm. The color gradient defines the local velocity field in m/s. Fluidic streamlines are shown by black lines while red arrows represent velocity vectors within the loading chamber. P is the pressure acting on the buffer column and is equal to the sum of the atmospheric pressure (P_{atm} = 1.01325 × 10^5 N/m^2) and the pressure of a 29 mm tall buffer column ($P_{h\rho g}$ = 284.49 N/m^2).

Fig. S4 Time-lapse images showing toluidine blue diffused from the luminal side to the basal side. The images were top view of the array (Fig. 3D). A high concentration gradient was established between two sides for the micromesh array.

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Fig. S1

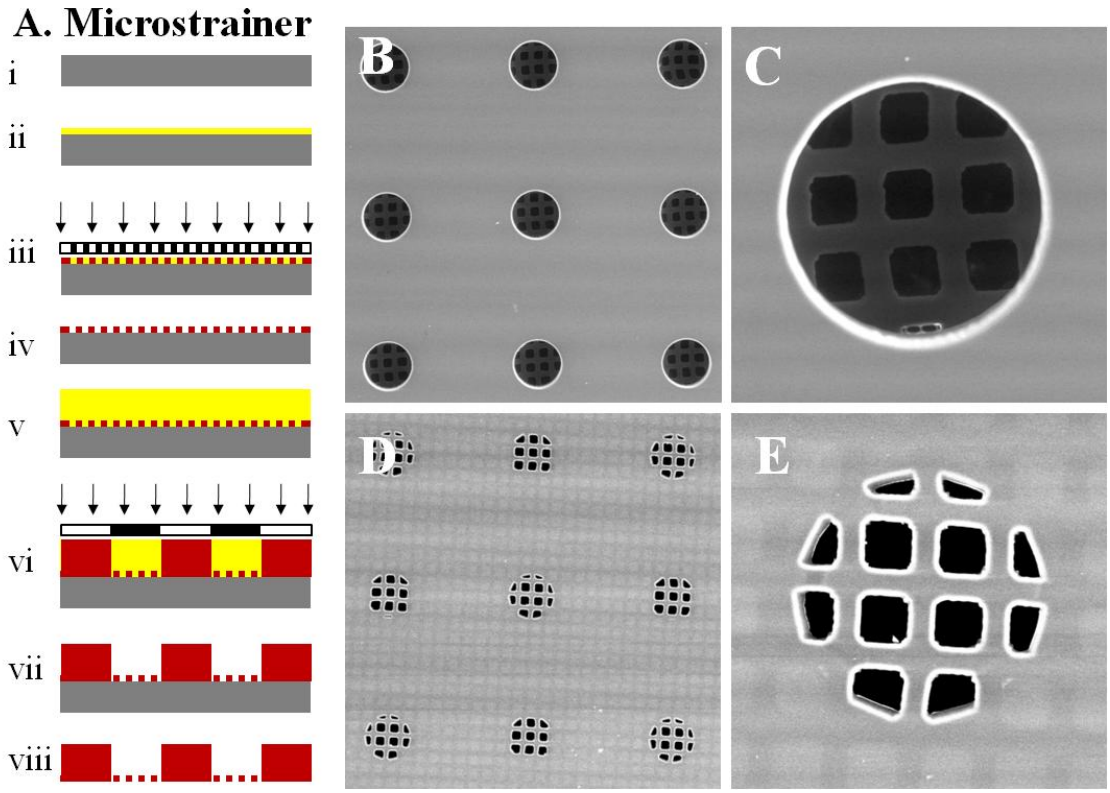

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Fig. S2

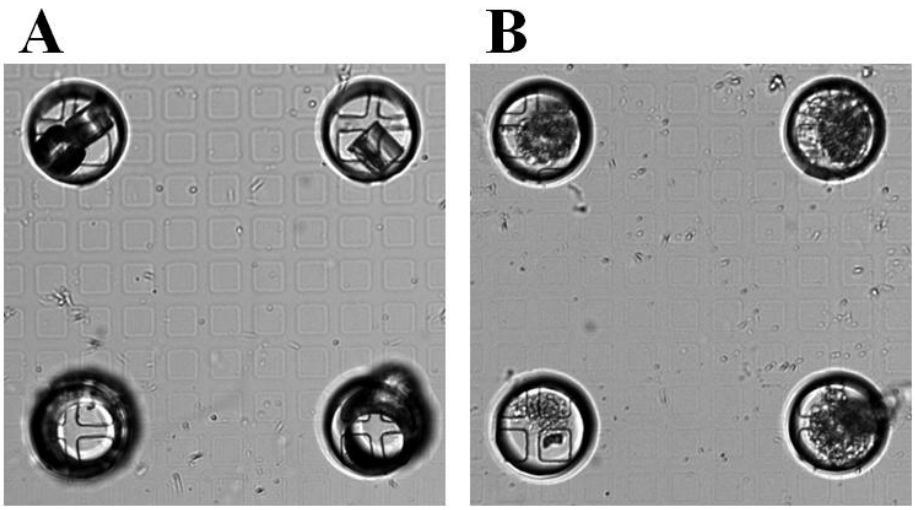

Fig. S3

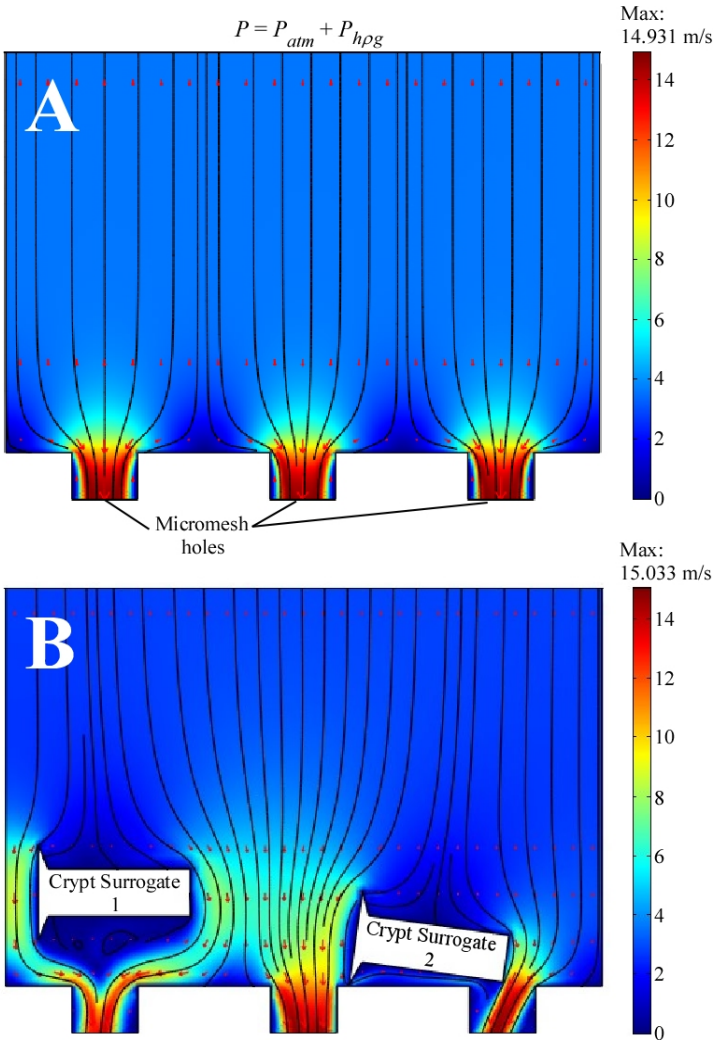

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Fig. S4