Supporting Information

Bioinspired Reconfiguration of 3D Printed Microfluidic Hydrogels via Automated Manipulation of Magnetic Inks

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Numerical Simulation: COMSOL Multiphysics software was used for finite element simulations of fluid flow and species transport inside the microchannels. Fluid flow inside the channel was modeled as a laminar, incompressible flow, and steady-state using the following governing equations:

$$\nabla \cdot u = 0;\ \rho(u \cdot \nabla u) = -\nabla P + \mu \nabla^2 u \quad (1)$$

where ρ, u, P, and μ denote density, velocity vector, pressure field, and dynamic viscosity, respectively. Species transport inside microchannel is formulated by the convection-diffusion equation as follows:

$$\frac{\partial c}{\partial t} + \nabla \cdot (-D\nabla c) + u \cdot \nabla c = 0 \quad (2)$$

Where c and D represent species concentration and diffusion coefficient. Throughout the simulations, water properties were considered for fluids ($\rho = 1000\ {kg}/{m^3}, \mu = 0.001\ Pa.s$). The flowrates were fixed at 100 µl/h for T-junction and FITC in flow-focusing geometry, and 5 µl/h for Rhodamine in flow-focusing geometry. The outlet in both cases was set as atmospheric pressure (P=0), and the walls were set as the no-slip boundary condition. For both cases, the concentrations were fixed at 0, and 1 for Rhodamine and FITC, respectively, and the diffusion coefficient between the species was set as 4×10^{-12} m^2/s.

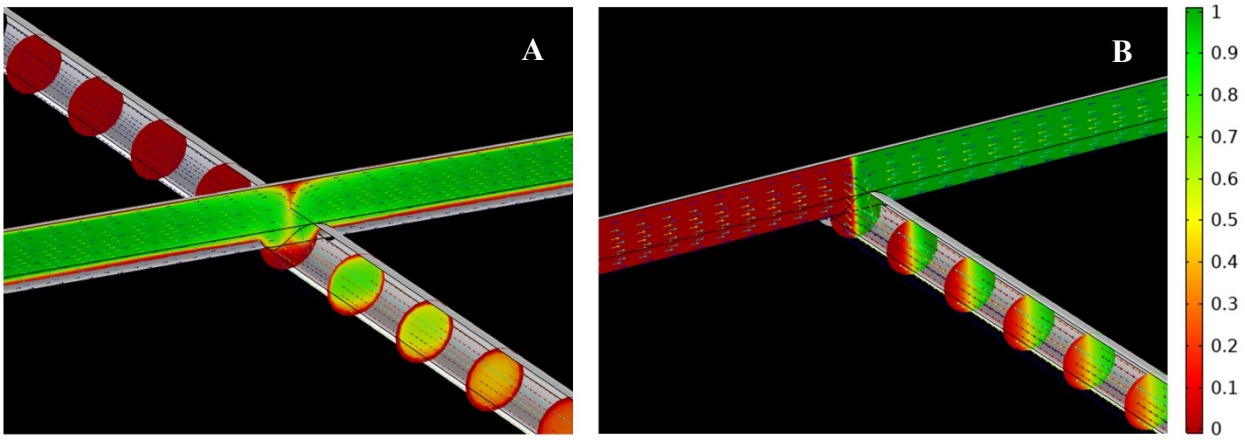

Figure S1 The numerical simulations of a) flow focusing and b) T-junction configurations are shown. The contours represent the concentration, and arrows are representatives of the velocity direction. This figure shows a good agreement with the experimental results.

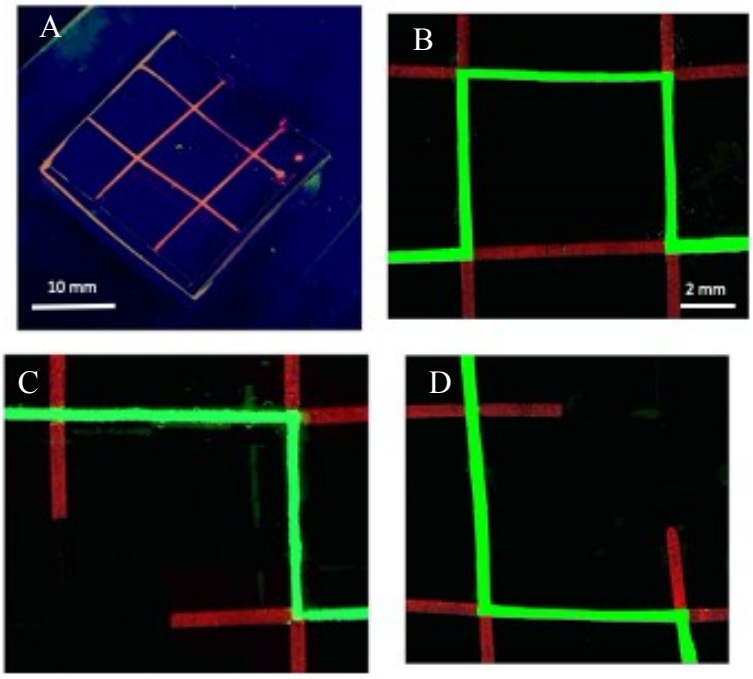

Figure S2 a) In order to illustrate the scalability of our proposed method, a four-junction GelMA microfluidic device was fabricated and (b-d) magnetic fiber fragments were introduced into the channels by inserting the capillary tube containing the magnetic bioink and injecting small volumes of the ink inside the channels. Afterwards, the magnetic fragments were moved to the pre-defined locations using an external magnet connected to a robotic arm to create the flow pattern shown in (b). By moving the horizontal and vertical magnetic fragments alongside the channels or guiding them to the outside using the external magnet, new configuration as shown in (c) and (d) could be created.