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

Supplementary Information for

Direct Loading of Blood for Plasma Separation and Diagnostic Assays on a Digital Microfluidic Device

Christopher Dixon,[1] Julian Lamanna,[1,2] Aaron R. Wheeler[1,2,3†]

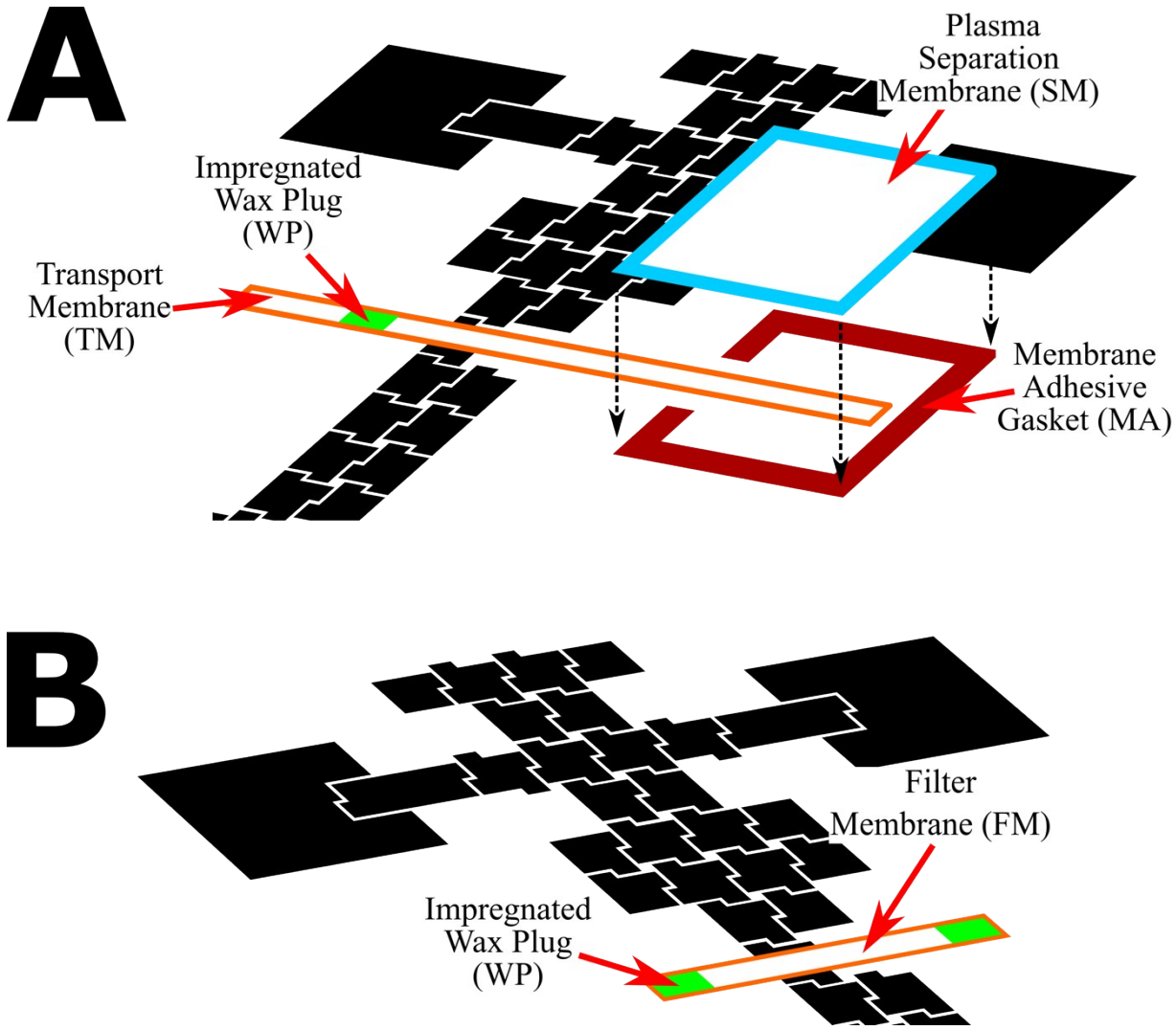
[1] Department of Chemistry, University of Toronto, 80. St. George Street, Toronto, Ontario, Canada, M5S 3H6

[2] Donnelly Centre for Cellular and Biomolecular Research, University of Toronto, 160 College Street, Toronto, Ontario, Canada, M5S 3E1

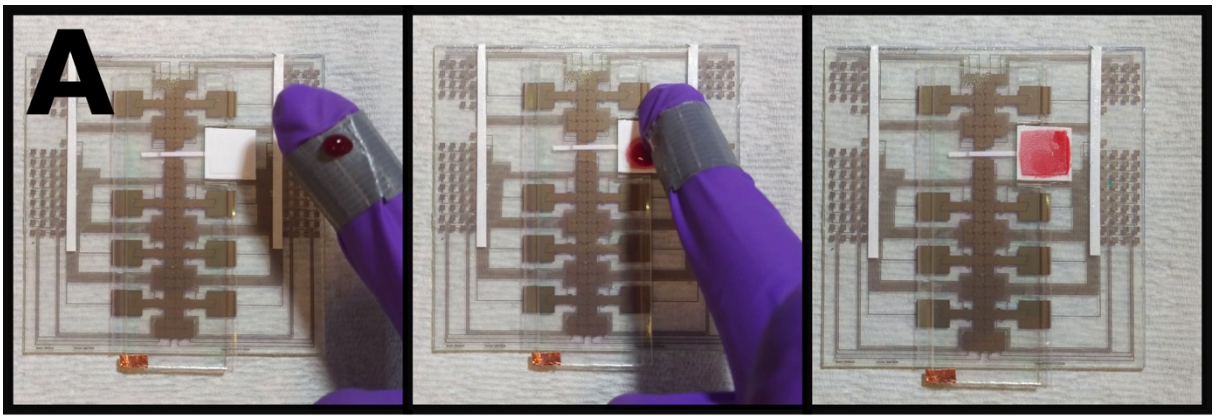
[3] Institute for Biomaterials and Biomedical Engineering, University of Toronto, 164 College Street, Toronto, Ontario, Canada, M5S 3G9

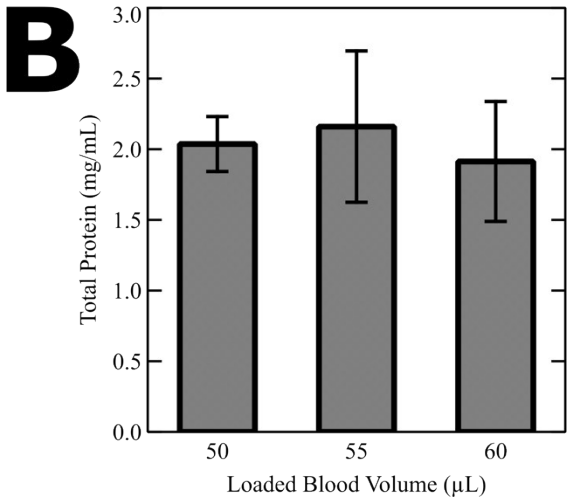
[†] Corresponding Author

A.R.W.
email: aaron.wheeler@utoronto.ca
tel: +1 416 946 3864
fax: +1 416 946 3865

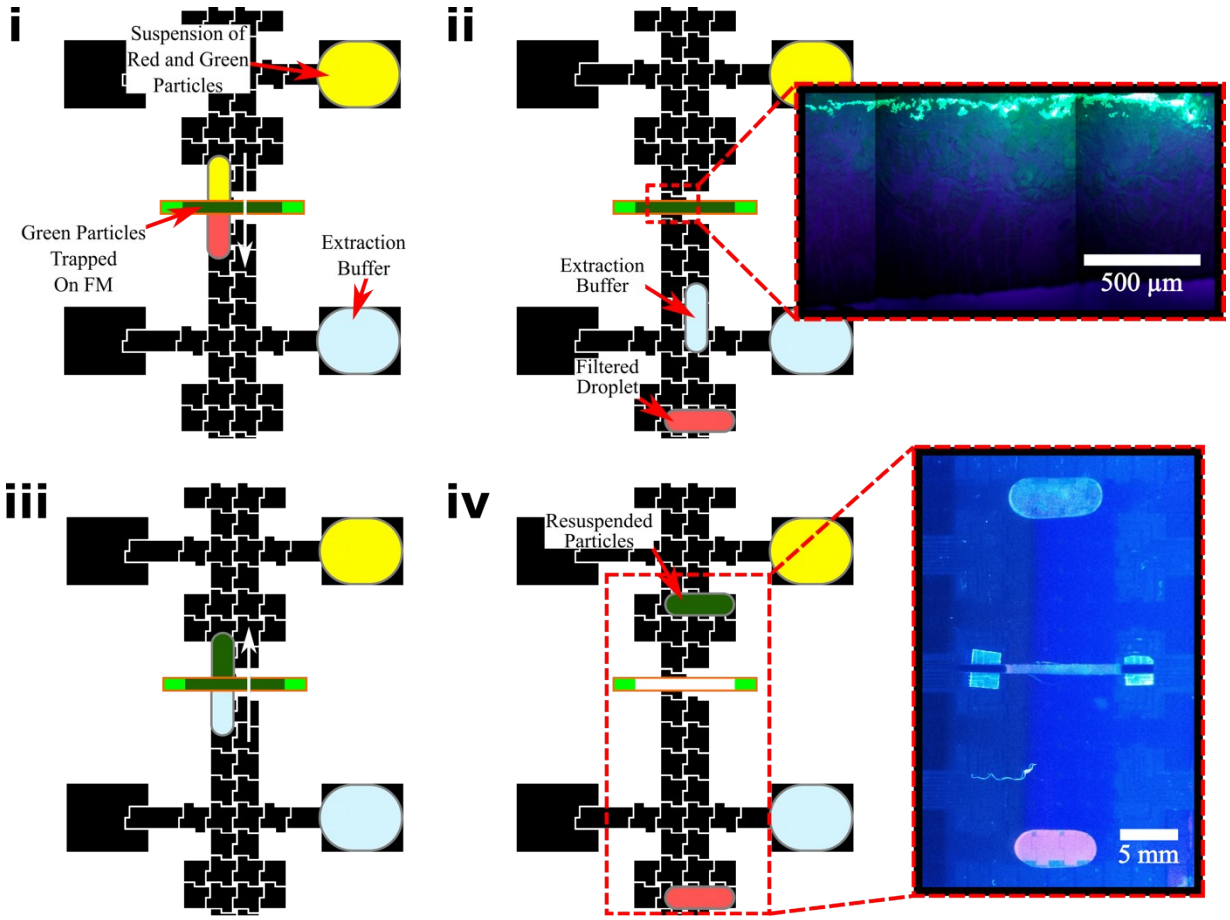


Supplementary Figure S1. Isometric-view schematics illustrating how membranes were assembled into DMF devices. (A) In devices used for blood-plasma separation, a transport membrane (TM, orange outline) bearing an impregnated wax plug (WP, green) is first positioned on the device as indicated. Second, a membrane adhesive (MA, red) gasket is placed on the device with the TM running through the opening. Third, a plasma separation membrane (SM, turquoise outline) is pressed on top of the TM, aligning its edges with the MA gasket. (B) In devices used for size-based particle separation, a filter membrane (FM, orange outline) bearing two impregnated wax spots (green) is positioned on the device as indicated.





Supplementary Figure S2. World-to-chip interface and sample loading. (A) Frames from supplementary movie M1 (left-to-right) demonstrating a whole blood droplet "dabbed" from a finger onto the SM. (B) Plot comparing the total protein measured in diluted plasma droplets generated from different volumes of blood loaded onto the device. Error bars represent ± 1 standard deviation from n = 3 replicates per condition.



Supplementary Figure S3. Cartoons (left) and pictures (insets, right) illustrating DMF particle separation. (i) A mixed suspension of green (large) and red (small) particles is dispensed and actuated through the FM perpendicular. (ii) The large (green) particles remain trapped on the membrane, while the small (red) particles pass through the membrane, remaining in the original droplet (post-separation). Inset (red dashed border): a composite of 3 photographs stitched together (collected under UV illumination) showing large (green) particles trapped at the edge of the FM. (iii) A droplet of extraction buffer is dispensed and actuated through the FM in the opposite direction. (iv) the extraction droplet collects the large (green) particles, such that the two types of particles have been separated into different droplets. Inset (red dashed border): photograph (collected under UV illumination) depicting the outcome of a DMF particle separation experiment.

Supplementary Note N1.

Reynolds Number Estimation

The determination of laminar or turbulent flow through a microfilter can be made by calculating the Reynolds number, Re, of the system (*Physics of Fluids*. **2014**, *26* (5), 052004). For flow with a porous network (microfilter) Re is calculated as,

$$Re = \frac{\rho U a}{\mu}$$

where ρ is the fluid density, U is the average velocity through the pores, a is the average pore radius, and μ is the viscosity of the fluid. In our system, typical values are $\rho = 1.05\ kg/m^3$, $U = 1 \times 10^{-3}\ m/s$, $a = 2.5 \times 10^{-6}\ m$, and $\mu = 1.05 \times 10^{-3}\ kg/m \cdot s$. Thus, in our system we expect $Re = 2.4 \times 10^{-6}$, which implies laminar flow.