Electronic Supplementary Material (ESI) for Analyst

Supporting Information

The estimates for the electroosmotic and pressure-driven transport rates reported in this work, e.g., data included in figure 2(b), were obtained based on the measured electroosmotic mobility of the fluid and the calculated electric field in segment D under the operating conditions. Actual Ohmic resistance measurements for the different channel segments were used in calculating this electric field applying Kirchhoff's and Ohm's laws. To estimate these resistances, 6 different voltages (0.5, 1, 1.5, 2, 2.5 and 3kV) were applied across a chosen pair of channel terminals and the electrical currents generated in response were measured. The effective resistance for the chosen fluidic circuit (Z) was then evaluated from the slope of the line fitted to this voltage-current data using linear regression analysis. For example, the combined resistance of segments A, D and F in our device was calculated based on the current-voltage measurements made across channel terminals 1 and 5 as $R_A + R_D + R_F = Z_{15}$. Similar measurements were then repeated across 5 other independent fluidic circuits to allow the determination of R values for all of the different channel segments in our device yielding the following linear system of equations.

$$\begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix} \begin{pmatrix} R_A \\ R_B \\ R_C \\ R_D \\ R_E \\ R_F \end{pmatrix} = \begin{pmatrix} Z_{15} \\ Z_{12} \\ Z_{13} \\ Z_{23} \\ Z_{14} \\ Z_{45} \end{pmatrix}$$

These expressions were solved using MATLAB to calculate the values of R_A through R_F which later were used to estimate the electrical current (I) in the different channel segments based on relationships listed below.

$$\begin{pmatrix} R_A & 0 & 0 & R_D & 0 & R_F \\ 0 & R_B & R_C & 0 & 0 & 0 \\ R_A & 0 & R_C & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & R_E & R_F \\ 1 & 1 & -1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & -1 \end{pmatrix} \begin{pmatrix} I_A \\ I_B \\ I_C \\ I_D \\ I_E \\ I_F \end{pmatrix} = \begin{pmatrix} V_1 - V_5 \\ V_2 - V_3 \\ V_1 - V_3 \\ V_4 - V_5 \\ 0 \\ 0 \end{pmatrix}$$

Here, V refers to the electrical voltage applied at the different channel terminals as shown in figure S1. Finally, the voltage drop across the separation channel was evaluated as the product of I_D and R_D which when divided by the length of segment D yielded the electric field in it.

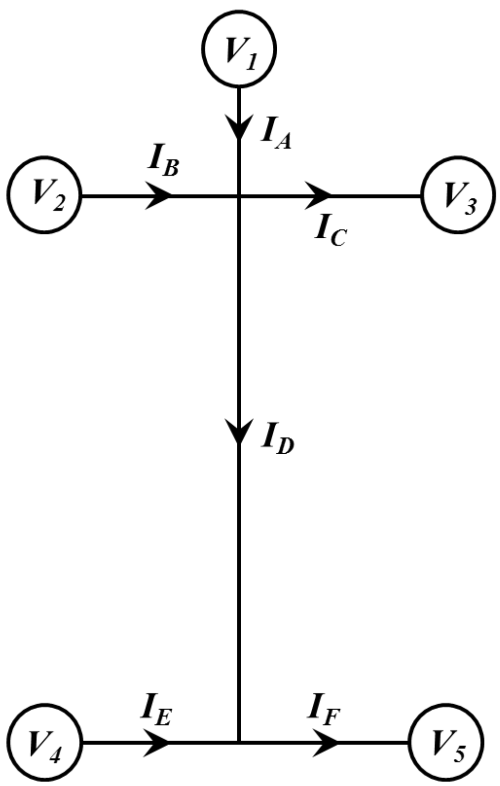

Figure S1. Equivalent electrical circuit for the microfluidic network employed in this work.