Electronic Supplementary Material (ESI) for Lab on a Chip

ELECTRONIC SUPPLEMENTARY INFORMATION (ESI)

Uniform Mixing in Paper-Based Microfluidic Systems Using Surface Acoustic Waves

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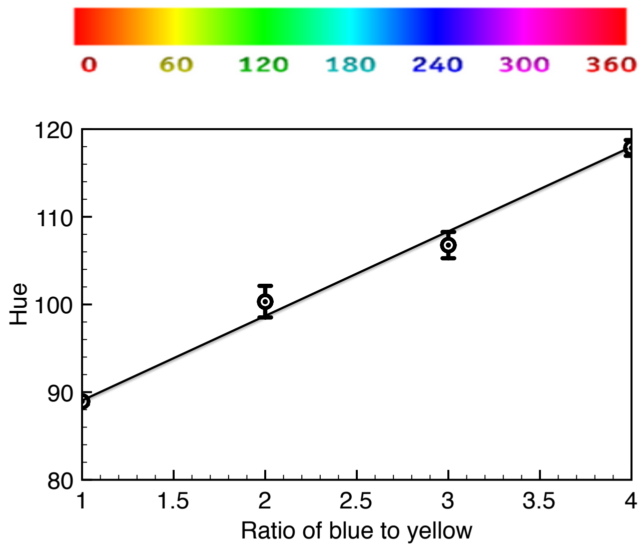

Figure S1 Hue values for different colours (top) and that of a mixture of two 10 μl drops containing varying concentrations of blue and yellow dye (bottom). The data was linearly fitted with $R^2 = 0.989$ ($n = 5$).

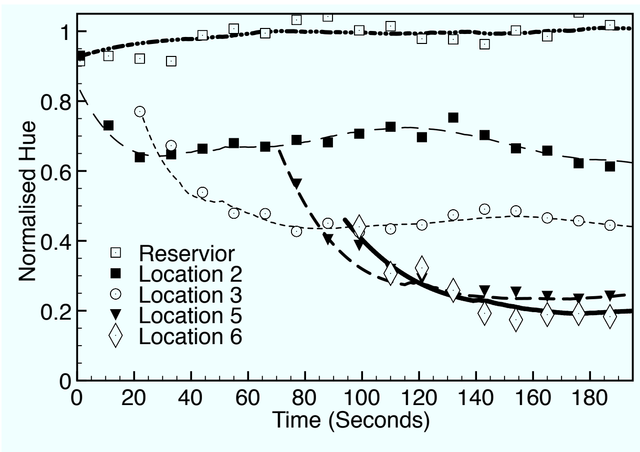

Figure S2 Mixing intensity (the normalised hue value given in Eq. (1) averaged across the pixels in a cross-section of the channel at several predetermined locations) as a function of time for the curved channel shown in Fig. 1(b). The normalised value of the fully unmixed (blue or yellow) states is 1 and approximately 0 for the fully mixed (green) state. We note that there is a slight increase in the hue value at the beginning of the experiment due to the initial filling of the channel; the steady hue values in the reservoirs, on the other hand, are accounted for in the normalisation of Eq. (1).

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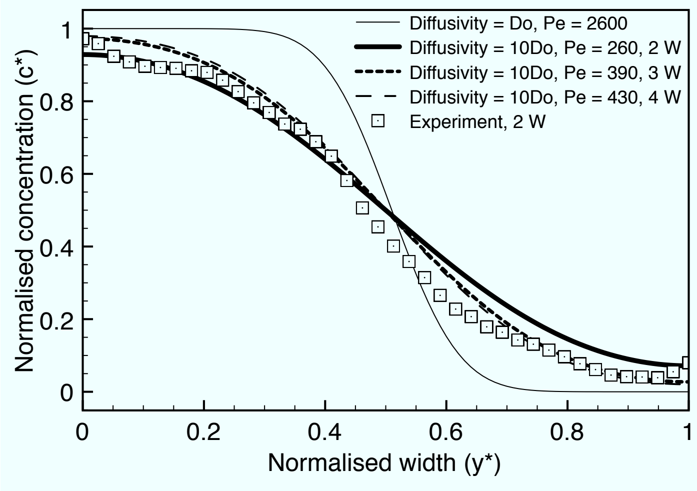

Figure S3 Comparison of the transverse concentration profile predicted by the standard convective-diffusive model (solid line) with that observed in the experiment (points) at a representative midpoint location along the channel x^* = 10. At a power of 2 W, the experimentally determined SAW-driven flow velocity U is 1.33 x 10^{-3} m/s in the 2 mm wide channel, corresponding to Pe = 2600. We note that the analytical prediction significantly underpredicts the mixing. To roughly quantify the mixing enhancement, we match the experimental concentration profile to the analytical solution with a modified Péclet number Pe_{eff}, which essentially corresponds to an effective diffusion coefficient D_{eff}. It can be seen that the experimental and analytical (bold solid line) profiles roughly match with a tenfold increase in the diffusivity, i.e., $D_{eff} = 10D_o$, and hence an order of magnitude decrease in Pe, i.e., Pe_{eff} = 260. Also shown by the dotted and dashed lines is the effect of increasing the input power of the SAW (associated with a corresponding increase in the flow velocity U), captured through an effective Péclet number in the analytical solution. In any case, the similar shaped trends between the experimental and analytical concentration profiles suggest that the mixing in the paper takes place through diffusion between the two laminar streams although we note that the interface between the streams is located at a slight offset from the middle of the channel y^* = 0.5 due to slight irregularities along the paper surface.