Supplementary Material for

Microparticle Manipulation in Viscoelastic Flows inside Curvilinear Microchannels: A Thorough Fundamental Study with Application to Simultaneous Particle Sorting and Washing

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1. Rheological Characterization of PEO-Spiked Water Solutions

A DHR-2 TA rheomter was used with a roughened 40 mm parallel plate geometry to measure the viscosity of PEO solutions. The measured viscosities are shown in Fig. S1 over a wide range of shear rates [1], where the shear thinning behavior is apparent specifically in the shear rate range of $\dot{\gamma}$<10,000 1/s. Here, the shear rate for each experiment could be calculated as shown in Eq. S1 [2]:

$$\dot{\gamma} = \frac{1.5\, V_x}{D_h} = \frac{1.5 Q_t}{A D_h} \tag{S1}$$

Here, D_h stands for the channel hydraulic diameter. V_x indicates the average axial velocity along the channel, which could be calculated using the total flow rate of co-flows (Q_t) and the channel cross section area (A).

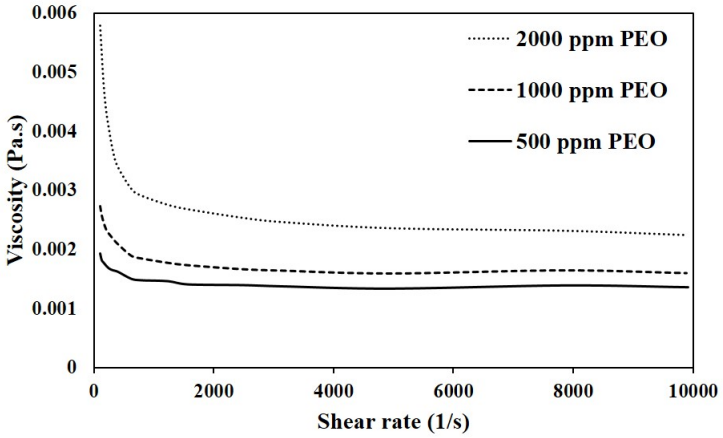

Fig. S1 *Viscosity measurement for PEO-spiked solutions at different shear rates using a roughened parallel plate rheometer. Three different concentrations of PEO solutions were tested up to $\dot{\gamma}$ = 10,000 1/s. The shear thinning behavior is apparent till $\dot{\gamma}$ ~ 5000 1/s, after which the viscosities could be considered constant.*

The relaxation times for these PEO concentrations were obtained from previous reports (according to the Zimm theory [3], [4]), i.e. λ = 4.3, 6.8, and 10.6 ms for PEO concentrations of 500, 1000, and 2000 ppm, respectively [5]–[7].

2. Solution Exchange Characterization

The purity of the solution exchange in the particle washing process demonstration, associated with the dissolved trypan blue concentration in PEO solutions, was examined using optical spectrophotometry. For this purpose, we measured the absorbance of different trypan blue concentrations (0% to 10 % v/v) in 500 ppm PEO solution using a UV-VIS spectrophotometer (Shimadzu, UV2600, Japan). As illustrated in Fig. S2, the absorbance peaks rise, as the trypan blue concentrations increase in 500 ppm PEO solution.

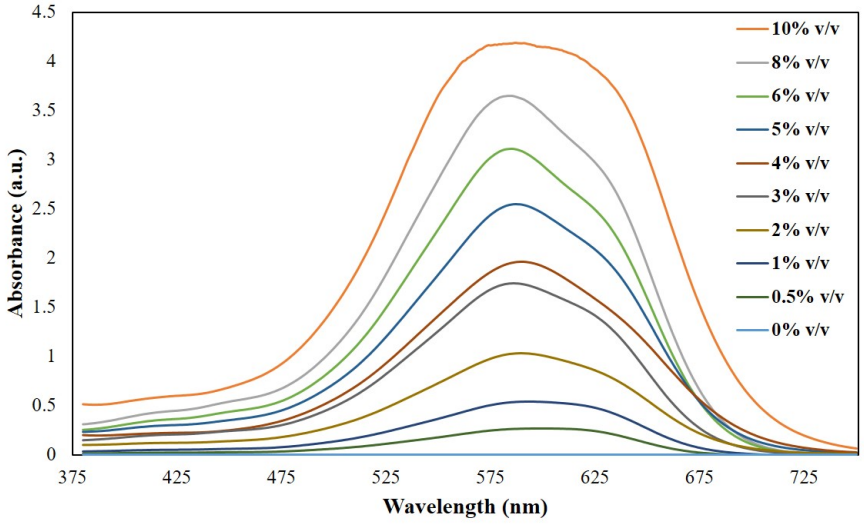

Fig. S2 *Absorbance of various trypan blue concentrations in 500 ppm PEO solution in the visible spectrum. Here, the 0% v/v concentration represents the undyed 500 ppm PEO solution, and a concentration of 10% v/v trypan blue indicates the dyed solution that was inserted into our devices.*

The absorbance peaks at a wavelength of ~ 590 nm were used to develop a calibration curve with respect to the concentration of the dyed inlet solution (10% v/v trypan blue). As shown in Fig. S3, a linear function (Eq. S2) was fitted over 0-40% data points with R^2 = 0.99.

$$y = 0.052\,x + 0.02 \tag{S2}$$

Here, y represents the absorbance of the solution and x stands for the concentration of collected solution with respect to the dyed inlet solution (i.e. 10% v/v trypan blue in 500 ppm PEO) The linear correlation in Eq. S2 could be used to characterize the solution exchange purity of the collected samples.

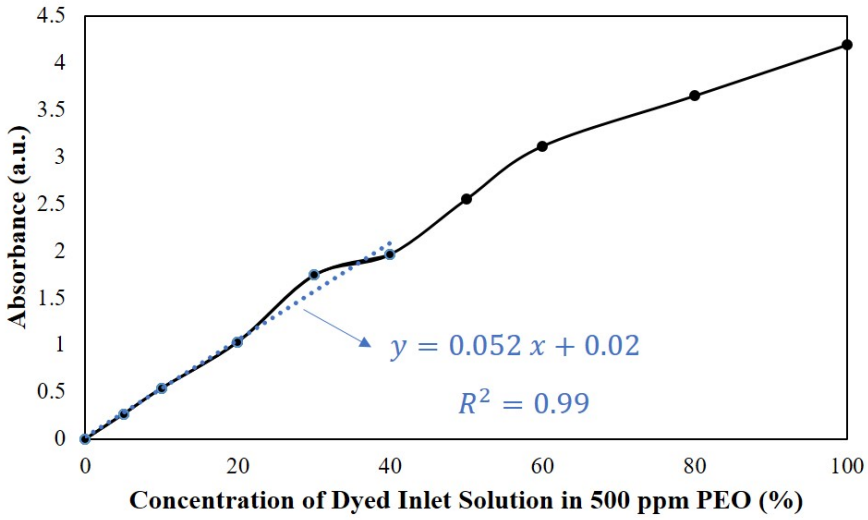

Fig. S3 *Absorbance vs. concentration of the dyed inlet solution (i.e., 10% v/v trypan blue in 500 ppm PEO solutions). A linear function could be fitted over the 0-40% concentration range with* $R^2 = 0.99$.

References:

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