Supporting Information

Robust Manufacturing of Lipid-Polymer Nanoparticles through Feedback Control of

Parallelized Swirling Microvortices

Michael J. Toth,[a] Taeyoung Kim,[a] and YongTae Kim[a-d]*

[a]George W. Woodruff School of Mechanical Engineering, [b]Wallace H. Coulter Department of Biomedical Engineering, [c]Parker H. Petit Institute for Bioengineering and Bioscience, [d]Institute for Electronics and Nanotechnology, Georgia Institute of Technology, Atlanta, Georgia 30332, USA

*Corresponding author:

YongTae Kim, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, 345 Ferst Drive (Rm 3134), Atlanta, GA 30332, (phone) 404-385-1478, (fax) 404-385-8535, (email) ytkim@gatech.edu
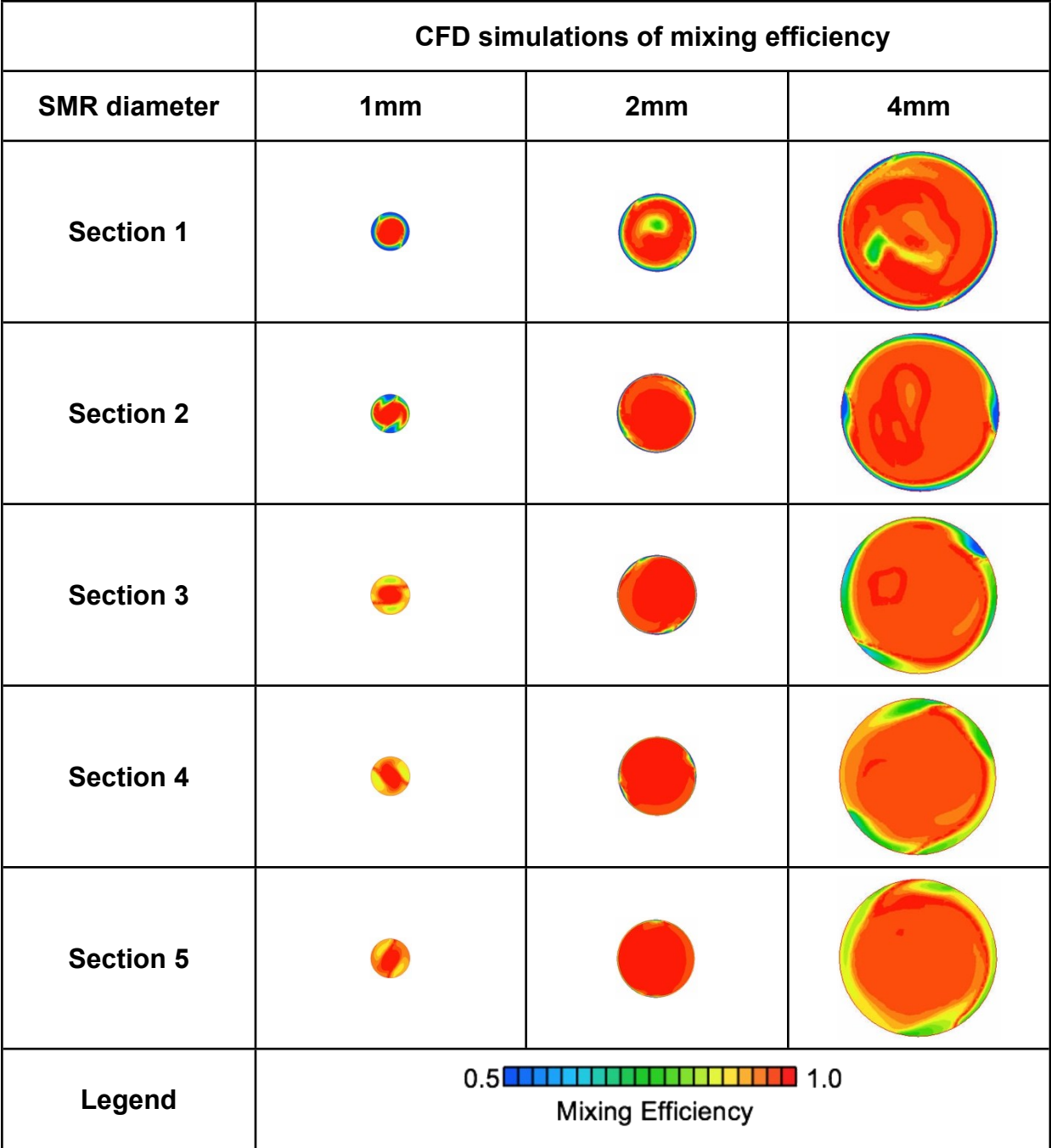
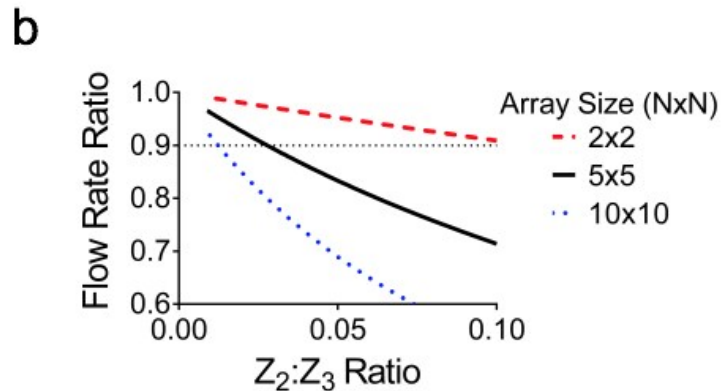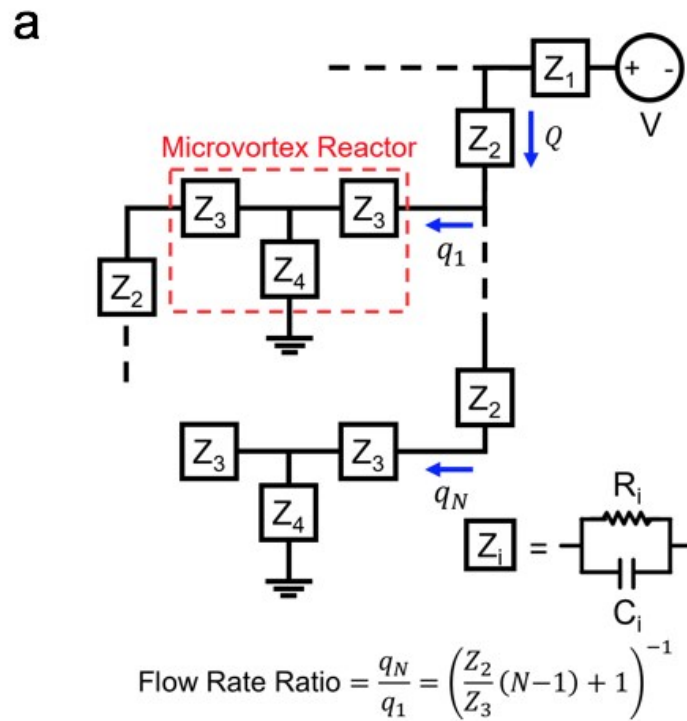| SMR diameter	CFD simulations of mixing efficiency		
	1mm	2mm	4mm
Section 1			
Section 2			
Section 3			
Section 4			
Section 5			
Legend	0.5 ▭▭▭▭▭▭▭▭▭▭▭ 1.0 Mixing Efficiency		

Fig. S1. CFD simulations of the SMR predicting the mixing efficiency at cross-sections along the height of the SMR with varied diameters (1mm, 2mm, and 4mm).

$$\text{Flow Rate Ratio} = \frac{q_N}{q_1} = \left(\frac{Z_2}{Z_3}(N-1) + 1\right)^{-1}$$

Fig. S2. Design of a parallelized microvortex array (PMA). (a) Fluidic circuit analog decomposition of the PMA network. Z_1 is the impedance of inlet channels connecting all branches of the SMRs. Z_2 is the impedance of the SMR-connecting channels. Z_3 is the impedance of the inlet of the SMR. Z_4 is the impedance of the SMR. Flow rate ratio is defined as the ratio between the inlet flows of the final to the first SMRs within a single column. (b) As the array size increases, the flow rate ratio of the fluidic circuit analog decreases more steeply with regard to Z_2:Z_3 ratio. The current PMA size is 5x5.
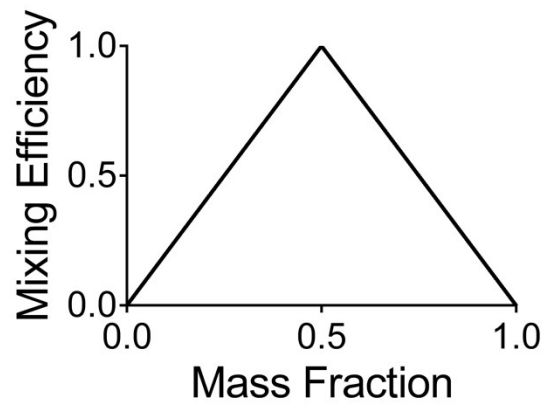
Fig. S3. Graphical representation of a mixing efficiency model.
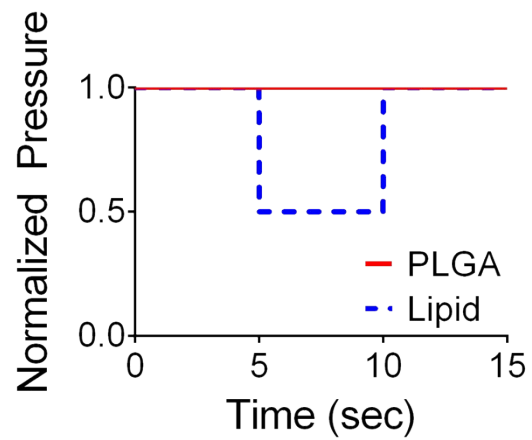
Fig. S4. Disturbance profile of LPNP precursor composition with an induced decrease in the lipid stream pressure.