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Fast and homogenous mixing in a coaxial capillary device with two sheath flows DIEGO A. HUYKE, ASHWIN RAMACHANDRAN, Stanford University, THOMAS KROLL, DANIEL P. DEPONTE, SLAC National Accelerator Lab, JUAN G. SANTIAGO, Stanford University — We have developed a novel microfluidic mixer with order 10 microsecond mixing times, and sample consumption of 1 to 500 nL/s. Importantly, the mixer achieves flow-area-weighted residence time distribution with a standard deviation width of 140 microsecond (for a 2.8 ms center-streamline residence time). In our mixer, the low flow rate sample stream which exits an inner capillary is hydrodynamically focused to a sub-micron radius by the high flow rate sheath stream within a tapered middle capillary. The mixed stream subsequently enters a third, outer capillary wherein its area (normal to the flow direction) is expanded 200 times to increase the sample detection volume. The latter expansion of the mixed stream decouples the upstream mixing region from the downstream probing region and increases the signal-to-noise (SNR) for line-of-sight integration techniques. The outermost capillary is constructed from glass or polyimide for, respectively, optical or hard X-ray sample detection. Analytical and numerical convection-diffusion models, design, and experimental validation of the mixer will be presented. The models will explore tradeoffs between mixing rate and homogeneity for different flow conditions. We validated the models and experimentally studied mixing performance using epifluorescence imaging of fluorescein-iodide quenching.

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