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Gravity driven flow for the precise control of hydrodynamic focusing

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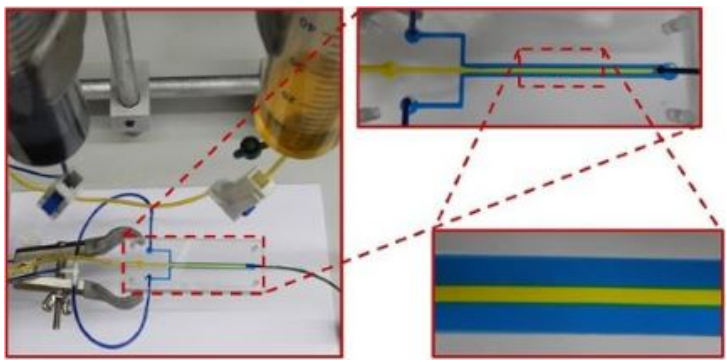
Hydrodynamic focusing is a key operation in microfluidics, with applications that range from cell sorting and counting to mixing and reactions. For most of these operations, both stability and precise handling of the focused stream are essential. However, these requirements are hardly attained when fluids are supplied by syringe pumps, due to the unavoidable fluctuations associated to the driving mechanical system, namely the stepper motor and the lead screw. As an alternative, this work presents a platform for controlled hydrodynamic focusing driven by gravity. In advance to previous works were the use of hydrostatic pressure has been proposed, here we describe a mathematical model to quantitatively handle the flow stream widths as a function of the fluid reservoir heights. The model enables a fine tuning of flow rates, provided the hydrodynamic resistance of the whole circuit is known. Focusing experiments were carried out at different flow rate ratios in PMMA/OCA film hybrid chips with slit microchannels forming cross-shaped intersections. Results were compared to those obtained when fluids are infused by syringe pumps to the same chips. It is demonstrated that the gravity driven system is successful for attaining highly stable and well-defined flow streams. Then, the crystallization of calcium carbonate was implemented in the gravity-driven systemas example of application. The reaction take place at the interface of co-flowing streams that transport the respective reactants, hence different final products are attained for different reservoir heights. Apart from enabling accurate fluid handling and stability, the model-controlled platform is highly versatile to design new experiments, as well as to assist the operator in practice.



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