Hydrodynamic Induced Deformation of Nano-Sieve Fluidic Device for Efficient Microparticle Trapping and Deposition

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The properties of colloid-based devices strongly depend upon the uniformity and concentration of the colloids.[1-2] Taking the advantage of the flexibility of the microfluidic structure, we demonstrate a portable and highly precise device that can efficiently trap, separate, concentrate, and release the colloids with a high flow speed. Leveraging the hydrodynamic induced deformation of the Polydimethylsiloxane (PDMS) layer in the "nano-sieve" device, microparticles are sorted with a high size selectivity. We first coat a thin silicon oxide layer on a glass substrate and then pattern a 2 mm wide and 8 mm long channel (depth ~1 µm) on the silicon oxide layer via standard photolithography and wet etching. A thick PDMS layer with punched holes (1.5 mm) is fused with the glass substrate to achieve the "nano-sieve" microfluidic device (**Fig. 1a**). Fluorescent colloids with diameters of 5 µm and 0.1 µm are pumped into the device with various flow rates. With the flow rate of 20 µL/min, a filtering efficiency of ~100% is recorded for 5 µm colloids as all the particles are trapped in the 8 mm long and shallow channel (**Fig. 1b and 1c**). The filtering efficiency decreases with the increasing flow speed due to the deformation of PDMS top layer, agreeing with our theoretical fluid-structure interaction model. In addition, all the 0.1 µm fluorescent colloids pass through the microfluidic device regardless of the flow speed. This study demonstrates a robust mechanism of filtering, concentrating, and releasing colloids with a transparent, miniaturized, and planar microfluidic design. The application of this mechanism and design has a great potential in biomedical imaging, quantum dot devices, and drug delivery.

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[2] M. Cryer, J. Halpert, "300 nm Spectral Resolution in the Mid-Infrared with Robust, High Responsivity Flexible Colloidal Quantum Dot Devices at Room Temperature", ACS Photonics. **5**(8), 3009 (2018).

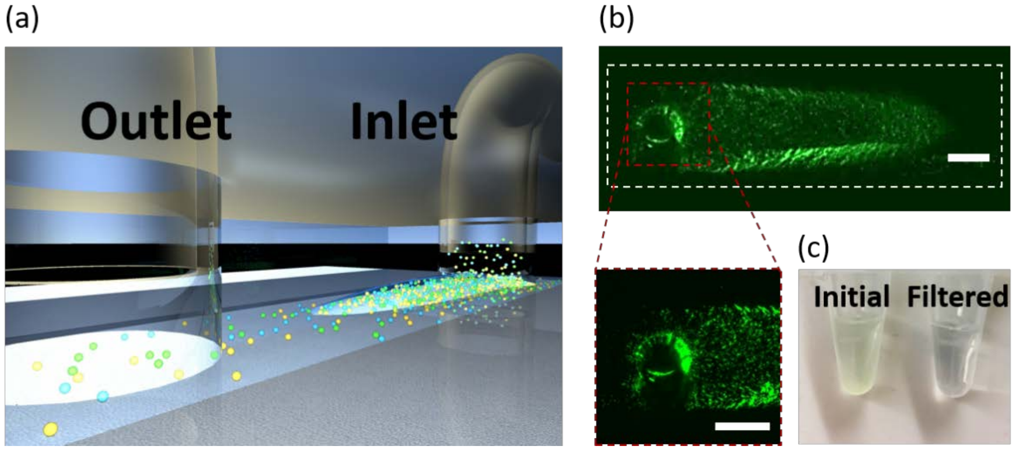

***Figure 1**: (a) Schematic of how the "nanosieve" micro-and nanofluidic device is used to separate the colloids. (b) Top view of the fluorescent colloids (diameter ~5 µm) trapped in the microfluidic device. (c) Colloids solution (diameter ~5 µm) before and after filtering (flow speed ~20 µL/min).*