Analytical separation of colloidal nanoparticles by size exclusion in soft nanofluidics

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Analytical separation by size exclusion in nanofluidic devices is an emerging method to manipulate and measure single nanoparticles with high throughput.[1] The accuracy of the method is remarkable, extending to the subnanometer scale, relying only on optical microscopy for instrumentation. However, the widespread application of this method requires the mass production of nanofluidic devices with complex structures that function simultaneously as separation matrices and reference materials. Here, we take the first step toward this goal by demonstrating the method in soft materials that are common for replica molding at the laboratory scale.[2]

Figure 1. (**a**) Brightfield optical micrograph showing staircase structures molded in a bilayer of hard and soft silicone, after bonding to a fused silica substrate to form an enclosed nanofluidic device. The staircase step depths vary from a minimum of 40.2 nm ± 1.2 nm to a maximum of 248.3 nm ± 4.4 nm below the zero plane, while the root-mean-square surface roughness of the steps remains constant at 0.26 nm ± 0.08 nm. Black regions are where the zero plane of the silicone replica has contacted the fused silica substrate, eliminating contrast from optical interference in a thin film. (**b**) Fluorescence optical micrograph showing the size separation of fluorescent polystyrene nanoparticles. (**c**) Histogram of nanoparticle sizes.

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[1] Subnanometer structure and function from ion beams through complex fluidics to fluorescent particles, K.-T. Liao, J. Schumacher, H. J. Lezec, and S. M. Stavis, *Lab on a Chip* **18**, 139-152 (2018).

[2] Rapid prototyping of nanofluidic slits in a silicone bilayer, T. P. Kole and K.-T. Liao et al., *Journal of Research of the National Institute of Standards and Technology* **120**, 252-269 (2015).