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Life in the Microfluidic Fast Lane

Many "lab-on-a chip" techniques have been developed to analyze small volumes, so that flow rate is not an important consideration. In some cases, however, novel physical phenomena enabled in microfluidic processes have applications which require high flow rates. This talk will examine challenges and approaches towards achieving high flow rates for particle fractionation and sorting using the Deterministic Lateral Displacement (DLD) technique [1].

DLD uses an array of posts tilted at a slight angle to that of the fluid flow, in which particles above and below a critical size flow in different directions. The method depends on the bifurcation of fluid around posts in a ordered fashion, and the "bumping" of large particles by the posts from one streamflow lane to another. It is well suited towards a scale-up in speed, since the deterministic nature of the sorting process does not require time for particles to diffuse as in many fractionation processes, and it actually has higher resolving power at high speed than low speed.

Fundamentally, the critical particle size is on the order of half of the gap between the posts. The narrow gap (for small critical size) and the no-slip condition at the post edges thus set a limit to flow rates at given pressure. We examine how the engineering of the post shape can be used to enable larger gaps, thus enabling substantially higher flow rates, and also to create fundamentally unusual flow properties. At high flow rates, the device behaves qualitatively similarly, but the particle behavior deviates somewhat from that at slow speed. Is this a fundamental or practical limit? Is this due to the fluid flow (non linear issues), the particles themselves, or their interaction.

1. L.R. Huang, E.C. Cox, R.H. Austin, and J.C. Sturm, Science **304**, pp.987-990 (2004)

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