Molecular transport through nanoscale channels

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The transport of fluids through nanoscopic conduits is an area of study that has received very little attention although it is fundamental to life. We call the fabrication of such conduits and the active transport of fluid through them nanofluidics. Studies leading to detailed understanding of nanofluidic transport will likely result in revolutionary technological capabilities. For example, the design of artificial cellular receptors may be possible that could result in sensitive and inexpensive sensors for chemical and biological agents or the ability to sequence *single* molecules of DNA at rates many orders of magnitude faster than presently possible. We have been investigating electrokinetic transport of fluids and polyelectrolytes through fabricated nanochannels formed in glass and silicon substrates. Interesting phenomena become apparent as channel dimensions are reduced from the 1-μm scale to ≈ 100 nm. Electroosmotic transport, under double-layer overlap conditions, has been studied and to our knowledge, this is the first experimental investigation that is directly comparable to existing continuum theories for such transport. We have also discovered that that new mechanisms arise for separating polyelectrolytes in free solution once the channel dimensions approach the hydrodynamic radius of the molecules. Recent experiments and future possibilities will be discussed.

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