Graduate Student Research Seminar

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AC Electrokinetic separation of nanoparticles in a ratchet microchannel

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Microfluidic techniques for particle manipulation are widely applied across various disciplines in both fundamental and applied sciences including biotechnology, drug discovery, and cancer research. Insulator-based dielectrophoresis (iDEP) has emerged as a powerful technique for the manipulation of micro- and nano-sized particles, enabling precise control over their motion and separation in microfluidic systems. This study investigates the AC iDEP separation of 100 nm and 500 nm nanoparticles in a ratchet microchannel, where their behavior is influenced by the ionic concentration of the buffer, AC field amplitude, and frequency. At low buffer concentrations (0.01–0.1 mM), an effective separation is observed, with faster-moving 100 nm particles effectively focusing into a narrow stream along the channel's centerline, while slower-moving 500 nm particles experience trapping near the constrictions (ratchet tips), a behavior attributed to their surface charge. With an increase in buffer concentration to 1 mM, 500 nm particles transition toward centerline focusing, whereas 100 nm particles disperse throughout the channel, diminishing separation efficiency. The distinct focusing behavior of the two particle sizes underscores the critical influence of buffer concentration on separation effectiveness. We also investigate how the variation of AC field amplitude and frequency affects the separation of nanoparticles within the channel.

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