Title: Silicon nitride and Indium Tin Oxide Nanostructures for dielectrophoretic manipulation of biomolecules

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Abstract: Nanofeatures on semiconductor and metal oxide are used for biomolecule sensing and low resolution sequencing of DNA. Classical nanochannel-based confinement methods have gained worldwide acceptance for the manipulation and trapping of single DNA molecules. Nanochannel based devices are typically derived on either in pure silicon or silicon dioxide. These devices allow highly parallel biomolecular analysis. Despite their widespread use for genomic and physical studies, inherent characteristics, these methods continue to limit the potential for dynamic manipulation and trapping of DNA molecules. They are limited either by sensing resolution or by low concentration of molecules at the nanofeatures.

In order to overcome technical challenges of conventional practices, we propose and demonstrate a novel technological approach, one that utilizes reversible, tunable nanofluidic confinement to immobilize and linearize DNA molecules for single molecule optical analysis– a design based on di-electrophoresis force and ITO patterned electrodes. In this study, the device of design contains a nano-patterned dielectric layer on silicon nitride that sits on top of an indium tin oxide. The second surface contains a uniform transparent conductor. An alternating electric field is then applied between the two surfaces. On the patterned surface, the field is concentrated in the conductive nano-features, leading to an enhanced local electric field magnitude. The DEP-force will gently drive the macromolecules into the nanofeatures and then confine them in the features, forcing the molecules to adopt a conformation determined by the local geometry of the patterning, including stretched conformations (in 1D-nanogrooves) and concentrated trapped conformations (quasi 0D cavity patterns).

The ease of fabrication and instrumentation may make our nanostructured device can be a unique point of care instrument for high resolution and highly sensitive biomolecular sensing.

Bio: Sara Mahshid is currently a Post-doc at McGill University, jointly appointed by Physics and Human Genetics Department. Her research interest is nanomaterials (nanotubes/nanowires)-based biosensing and nano/microfluidics lab-on-chips for biomedical application such as single cell/ single DNA molecule analysis and nanoscale biomolecular detection. Sara earned MSc and PhD degrees in Materials Science and Engineering at Sharif University of Technology, Iran. Before starting her postdoc research at McGill, she was a full time lecturer (teaching and research) at Engineering Department of Monash University Sunway Campus. Sara has over ten years of research, teaching, mentoring, supervising and service experience. Her publication record is extensive with twenty-one articles including publications in Lab-on-a-chip, Analyst, and PNAS.