Polymer Nanopore Devices for Sensing Biomolecules

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The recent development of nanofabricated structures offers promising and highly innovative new approaches to obtain biophysical information from single molecules. In the last two decades, intensive efforts have been reported to fabricate nanoscale pores and use them as a sensing platform to detect and identify single biomolecules with a key target application being DNA/RNA sequencing. In nanopore sensing, a translocating single molecule at the nanopore temporarily modifies the current flow, which is used as a molecular signature for identification. While biological nanopores provide well-defined pore sizes, shapes and chemical composition, solid-state nanopores have also emerged because of their chemical, thermal, and mechanical stabilities as well as controllability over pore diameter and location during fabrication. Most of sub-10 nm solid-state nanopores used for DNA analysis have been produced in inorganic substrates such as silicon dioxide, silicon nitride and glass capillaries via high-energy beam nanofabrication tools such as focused ion beam (FIB), focused electron microscopy and a laser-assisted puller. Despite the successful demonstration of nanopore devices for laboratory-scale DNA analysis, the combination of high-end nanofabrication tools and inorganic substrates limits the scalability of fabricating nanopore devices to high yield production because of the serial nature of the fabrication tools and rather slow deformation of inorganic substrates.

This invited talk will present our recent efforts to produce nanopore devices in polymer substrates using nanoimprint lithography (NIL), a high-throughput and low-cost nanomanufacturing method. Both nanofluidic devices containing nanopore membranes and in-plane nanopores have been demonstrated and successfully used to detect different biomolecules. Our work implies that NIL can also contribute to high throughput manufacturing of nanopore devices, which is critical to high-rate acquisition of genomic and/or molecular information required for personalized/precision medicine.