NANO HIGHLIGHT
Nanofluidic Networks for Single Molecule Protein Analysis

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A new nanofabrication process for creating nanoscale fluid channels in polymer chips has been developed. The simple process, based on thermomechanical deformation, can quickly create thousands of interconnected nanochannels for use in ultra-sensitive biomolecular detection systems. By separating molecular species in the channels and measuring the locations of individual molecules by confocal microscopy, the technology is being explored as a disposable analytical platform for low-cost and high-throughput measurements of proteins from within single cells.

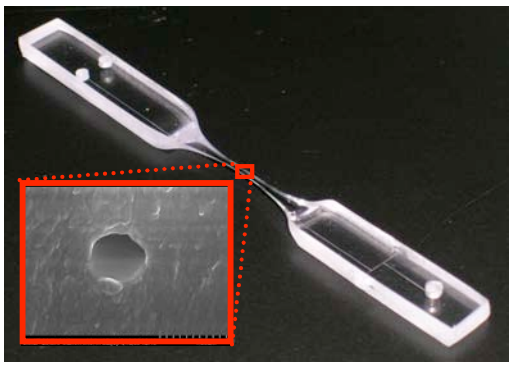

Fig. 1 Nanofabricated chip containing 700 nm diameter channels.

The thermomechanical nanochannel process employs thermoplastic preforms containing channels with relatively large (tens of microns) critical dimensions. By deforming a plastic preform above its glass transition temperature, the cross-sectional dimensions may be controllably reduced by several orders of magnitude. Since only a portion of the substrate is deformed, the final device can contain both microscale and nanoscale channels in the same chip, allowing the fabrication of microscale features for system-level functionality such as pumping, metering, and reagent mixing. Fully enclosed channels with diameters down to 200 nm have been realized using this approach. A typical nanofluidic chip fabricated using the thermomechanical deformation method is shown in Fig. 1. This chip contains two 700 nm diameter circular channels drawn down from initial preform channels with trapezoidal cross-sections of 30 μm depth and 20 μm width at half-depth. Large numbers of nanochannels are readily fabricated in a single substrate, such as the 30-channel array shown in Fig. 2. Channel geometry may be controlled using a number of process parameters, with an order-of-magnitude variation in diameter possible between different channels on a single chip.

Current research is focused on performing separations of complex protein mixtures in nanochannel networks, coupled with single molecule detection. We plan to extend the concept to separations similar to traditional 2-D gel analysis, but applied to single-cell proteomic studies. Single molecule detection within the nanofluidic chips using a mixture of model proteins have been successfully obtained.

References

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