Fracture Fabrication & Nanoscale Squeezing of Cells, DNA and Chromatin
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Abstract: This presentation will describe the fabrication and use of cross-sectional size-adjustable elastomeric channels. These normally-closed channels are fabricated by controlled fracture of brittle films sandwiched between poly(dimethylsiloxane) (PDMS). Arrays of these crack-based conduits with defined spacing between channels are created by introducing flaw-shielding structures and applying a tensile strain that matches the channel spacing desired. Crack depth is controlled by using brittle films with relatively small mechanical property mismatch with the bulk substrate. By controlling thickness of the brittle film, channels can be created with widths and depths of tens of micrometers down to nanometers. The micrometer sized channels are useful for single cell capture and lysis, for example, to lyse cells and release their nuclear contents such as DNA and chromatin. The nanometer sized channels are useful for linearization of single strands of DNA and single chromatin fibers. These channels are loaded with DNA and chromatin by simply stretching open the normally-closed channels. The wider channel openings, coupled with the associated inflow of fluids enable easy biopolymer loading without use of any other fluidic pumping or electrophoresis. Once inside the channel, the biopolymers can be linearized by releasing the tensile strain to narrow the channels. The combined hydrodynamic fluid flow together with nanoconfinement aids in linearizing, then trapping the linearized biopolymers. This method is gentle enough to distinguish differences between chromatin reconstituted with and without histone H1 and is also sufficiently forceful to enable linearization of lambda DNA up to ~97% of its contour length.

Prof. Shuichi Takayama's research interests (B.S. & M.S. from the University of Tokyo, Ph.D. from the Scripps Research Institute) started with organic synthesis. Subsequently he pursued postdoctoral studies in bioengineered microsystems at Harvard University as a Leukemia and Lymphoma Society Fellow. He is currently Professor at the University of Michigan in the Biomedical Engineering Department and Macromolecular Science and Engineering Program, and an Adjunct Professor at School of Nano-Bioscience and Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST). He is an associate editor of *Integrative Biology*. Research topics include microfluidic models of the body such as the oviduct, lung, and cancer metastasis. He also develops aqueous two phase system micropatterning technologies, studies timing and rhythms of cell signaling, constructs self-switching fluidic circuits, and performs nanofluidic single strand chromatin analysis. Awards include the NSF CAREER award and Pioneers of Miniaturization Prize from the Royal Society of Chemistry.