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Nanofluidic Lab-on-a-chip for DNA analysis

The entropic confinement of DNA in nanofluidic devices – where the DNA is localized and streched but not tethered to a surface - is a powerful tool for manipulating single DNA molecules [1]. In particular, measuring physical or genomic properties such as sequence mapping [2,3] of single molecules is made possible by confining DNA in nanochannels and imaging by fluorescence microscopy.
Loading such nanofluidic devices with a human sample e.g. from a cell culture is a major step toward realizing the potential of a nanofluidic Lab-on-a-Chip for genomics. In particular, extracting and visualizing long DNA molecules would be highly desirable for the mapping of long range features on the genome. We address this challenge by investigating three different routes toward extracting DNA through proteolysis of metaphase chromosomes on the chip. The concepts behind the 3 methods investigated are (a) proteolysis under no mechanical stress [4], (b) proteolysis under shear stress and finally, (c) proteolysis and DNA manipulation activated by light induced local heating (LILH) [5]. We present a nanoimprinted polymer chip with a thin near-infrared absorber layer that enables light-induced local heating (LILH) of liquids inside micro- and nanochannels. An infrared laser spot and corresponding hot-spot could be scanned across the device. Large temperature gradients yield thermophoretic forces, which are used to manipulate and stretch individual DNA molecules confined in nanochannels. Finally, the volume fabrication of nanofluidic Lab-on-a-Chip for DNA analysis by Roll-to-Roll nanoimprinting [6] and Injection Mouldning [7] is discussed.

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