Bonding of PMMA nanofluidic devices and its effect on DNA behavior in nanochannels

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Nanochannel-based fluidic devices have shown tremendous potential in real-time DNA/RNA analysis[1], DNA mapping[2], electrochemomechanical battery[3] and other applications. Compared to Si/SiO_2 substrates that are normally used for nanochannel fabrication, polymer substrates have the advantages such as versatile surface properties, biocompatible, easy-fabrication, low cost etc. However, one big issue for all polymer-based nanofluidic devices is how to obtain a good bonding of nanochannels without break or block the nanochannel and whether the different bonding methods affect the behavior of biomolecules in the nanochannels.

In this paper, we show fabrication of nanofluidic devices in polymethylmethacrylate (PMMA) via two bonding methods and the effect of the bonding methods on the behavior of DNAs in the devices. Nanofluidic structures consisting of nanochannels and microfluidic networks were fabricated using NanoImprint Lithography (NIL) with a polymer stamp. The use of a polymer stamp leads to a significant reduction of undesired deformation during NIL due to the reduced adhesion and thermal stress. Two bonding methods used to seal the nanofluidic devices are oxygen plasma assisted bonding and solvent assisted bonding, which were combined with application of air pressure. Compared to the conventional pressure application method by two parallel platens or clips for bonding fluidic chips, air pressure ensures homogeneous application of pressure over the entire chip area. Fluorescein test shows both methods can achieve good bonding without any leakage or blockage (Figure 1). The deformation of nanochannel after bonding was estimated reversely from the elongation of λ-DNA and T4-DNA inside nanochannels using the de Gennes' and Odijk's theory (Figure 2). The results showed that the dimensions of bonded channels varied less than 10% from the original sizes. Furthermore, the incidences of DNA cleavage were different in these two bonding methods, which is attributed to different concentrations of oxygen radical residues on the PMMA surface,.

1. Liang, X.G. and S.Y. Chou, Nano Letters, 2008. 8(5): p. 1472-1476.
2. Persson, F. and J.O. Tegenfeldt, Chemical Society Reviews, 2010. 39(3): p. 985-999.
3. Daiguji, H., et al., Nano Letters, 2004. 4(12): p. 2315-2321.

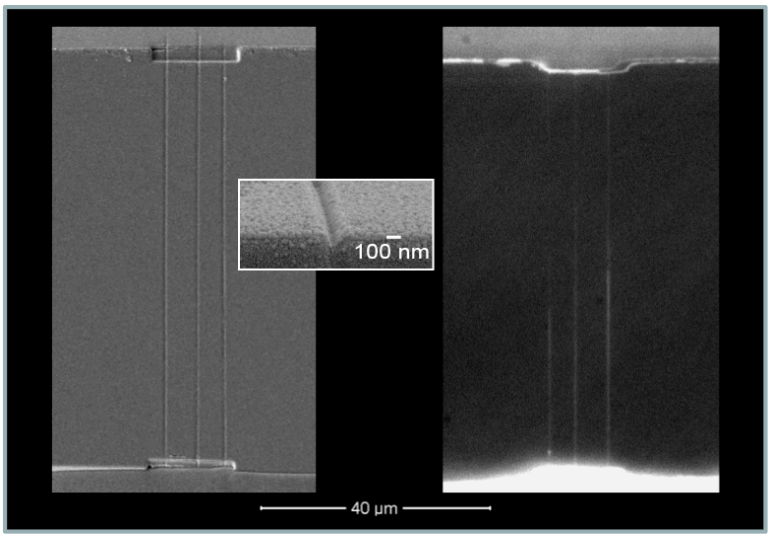

Fig 1. Top and cross-section SEM images of nanochannel and FITC image of bonded nanofluidic system

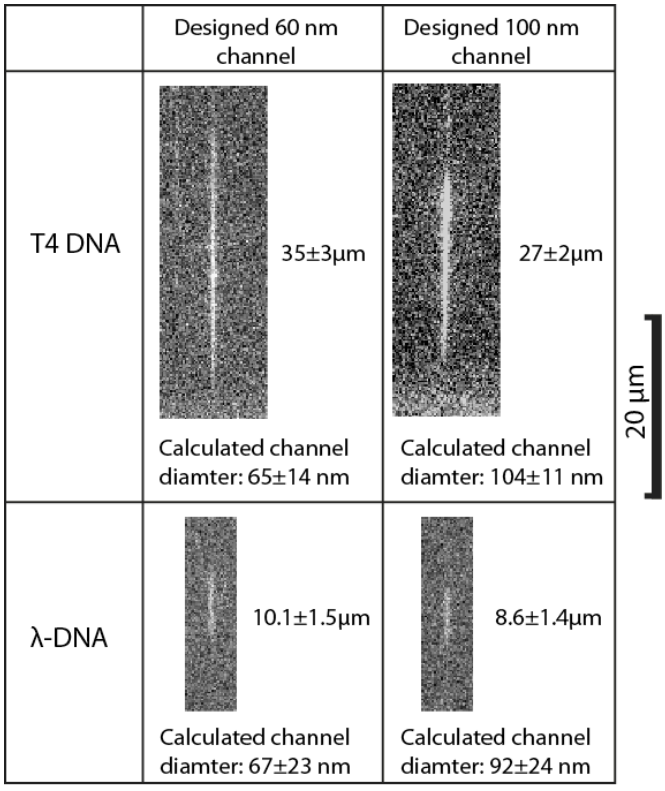

Fig 2. DNA elongation inside nanochannel (λ-DNA and T4 DNA)