249d Effect of Surface and Microelectrode Properties on the Dielectrophoretic Stretching of DNA

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Manipulation of single molecules such as DNA, RNA, and proteins has facilitated significant advances in biology. For example, the mechanical properties of single molecules have been obtained by using optical and magnetic tweezers, and the functioning of molecular motors has been investigated by examing the behavior of single kinesin molecules. The stretching of single DNA molecule is also one of the common methods in single molecule manipulation and has been of considerable interest to biochemists. This interest is largely due to the fact that single-molecule stretching can provide a precise tool for studying the interaction between DNA and protein molecules. Another reason for this interest is that via stretching a DNA molecule can be digested into small analyzable fragments with order information, a technique that can save considerable time and labor in certain DNA sequencing and genotyping methods.

DNA molecules can be stretched by electrostatic, hydrodynamic or magnetic force, and we have used dielectrophoretic DNA stretching in this work. We have found that the surface properties and the electrode characteristics of the device affect this dielectrophoretic stretching. For example, we found that the hydrophilicity of the surface between the electrodes affected the degree to which we could reliably stretch single DNA molecules. Using lamda phage DNA, we found that low contact angle surfaces (hydrophilic) between the electrodes decreases the efficiency of stretching. The surfaces treated with the higher silane (trimethyl chlorosilane) concentrations performed better presumably due to the decreased non-specific adsorption of DNA on these surfaces compared to their more hydrophilic counterparts. The shape and dimensions of the electrodes also affected the efficiency of stretching. Both lift-off and metal etching methods produced electrodes with random microscopic peaks along the electrode's edge producing high field gradients at these points. Annealing of gold electrode (450°C for 10 min) removed most of these peaks and allowed more controlled stretching to be obtained. We will discuss these and other parameters that can be used to optimize the dielectrophoretic stretching of DNA.