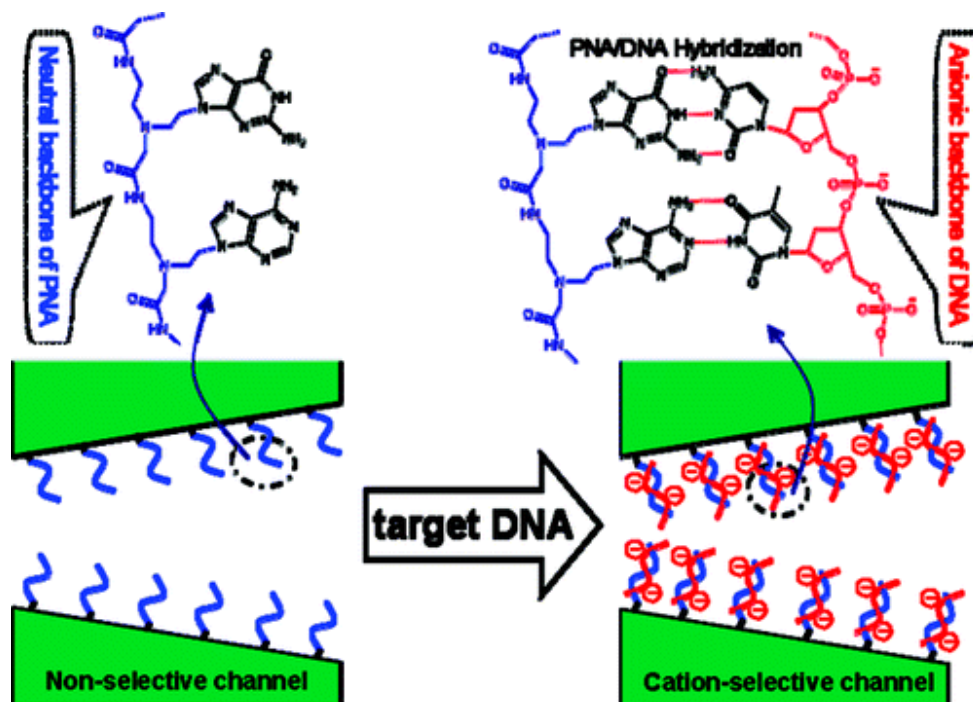


Sequence-Specific Recognition of DNA Oligomer Using Peptide Nucleic Acid (PNA)-Modified Synthetic Ion Channels: PNA/DNA Hybridization in Nanoconfined Environment

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Here we demonstrate the design and construction of a simple, highly sensitive and selective nanofluidic sensing device, based on a single synthetic conical nanochannel for the sequence specific detection of single-stranded DNA oligonucleotides. The biosensing performance of the device depends sensitively on the surface charge and chemical groups incorporated on the inner channel wall that act as binding sites for different analytes. Uncharged peptide nucleic acid (PNA) probes are covalently immobilized on the channel surface through carbodiimide coupling chemistry. This diminishes the channel surface charge, leading to a significant decrease in the rectified ion current flowing through the channel. The PNA-modified channel acts as a highly specific and selective device for the detection of a complementary single-stranded DNA sequence. Upon PNA/DNA hybridization, the channel surface charge density increased due to the presence of the negatively charged DNA strand. The changes in the surface charge-dependent current–voltage (I – V) curves and rectification ratio of the channel confirm the success of immobilization and PNA/DNA hybridization within a confined space at the nanoscale. In addition, a control experiment indicated that the biosensor exhibits remarkable specificity toward a cDNA strand and also has the ability to discriminate single-base mismatch DNA sequences on the basis of rectified ion flux through the nanochannel. In this context, we envision that the single conical nanochannels functionalized with a PNA probe will provide a biosensing platform for the detection and discrimination of short single-stranded DNA oligomer of unknown sequence.