

2価カチオンを用いた絶縁破壊法により形成した SiN ナノポアによる DNA 通過速度遅延化と 4 種モノマ塩基の識別

Silicon nitride nanopore created by dielectric breakdown with a divalent cation:

Deceleration of translocation speed and identification of single nucleotides

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Nanopore DNA sequencing with a solid-state nanopore requires deceleration of the ultrafast translocation speed of single-stranded DNA. We report an unexpected phenomenon: controlled dielectric breakdown (CBD) with a divalent metal cation, especially Ca^{2+} , provides a silicon nitride nanopore with the capability of decelerating DNA speed down to 100 $\mu\text{s}/\text{base}$ even after solution replacement. This speed is two orders of magnitude slower than that for CBD with a conventional monovalent metal cation. This slowing effect strongly depends on temperature, and only a 40 °C temperature drop induces further deceleration of DNA speed down to 7300 $\mu\text{s}/\text{base}$. The slowing effect originates from the strong interaction between DNA and divalent cations, which were coated on the sidewall of the nanopore during the CBD process. In addition, we found that a nanopore created via CBD with Ca^{2+} can decelerate the speed of even single nucleotide monomers, dNMPs, down to 0.1 - 10 ms/base. The four single nucleotides could be statistically identified according to their blockade currents.

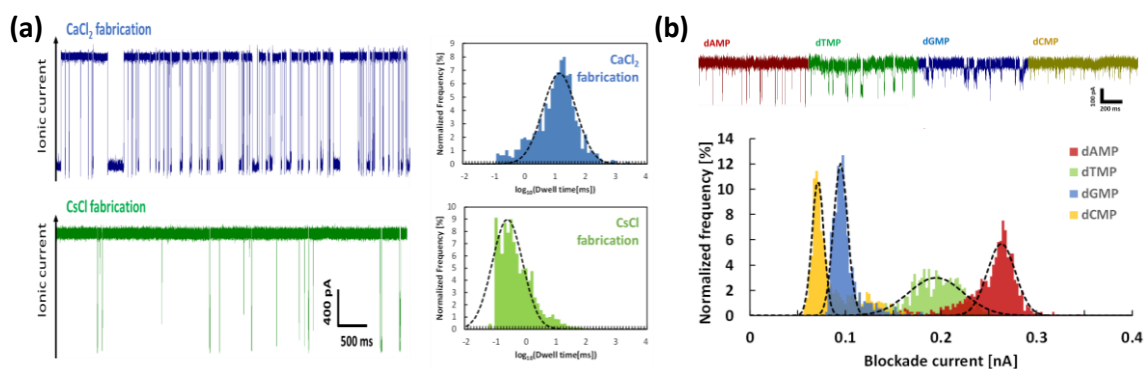


Figure 1. (a) (Left) Typical DNA translocation through a SiN nanopore fabricated by CBD with a divalent or a monovalent cation. (Right) The log-scaled normalized histograms of dwell time for 82-nt ssDNA translocation through a SiN nanopore fabricated by CBD with the cations. (b) (Upper) The typical concatenated current trace for dNMP translocations across a nanopore fabricated via CBD with CaCl_2 . (Lower) The normalized histogram for blockade current of each dNMP translocation.