Enhancing the Sensitivity of DNA Detection by Structurally Modified Solid-State Nanopore

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Since the first appearance of solid-state nanopore, there have been several approaches to enhance sensitivity and reliability of biomolecule detection using the nanopores, in two aspects of signal-to-noise ratio (SNR) and translocation dwell time. Efforts to enhance SNR include increasing the signal magnitude and reducing electrical noise. [1] To increase DNA translocation dwell time, mechanical drag has been exerted directly on DNA using optical tweezer or magnetic tweezer, [2] or DNA-surface interactions have been induced to slow down DNA using sticky materials like graphene [3] or nanoporous gel media near the nanopore. [4] In this work, an additional nano-well with 100~150 nm of diameter and the aspect ratio of ~5 called 'guide structure' is inserted in conventional silicon-substrate nanopore device to increase both SNR and dwell time. Firstly, the magnitude of signals (conductance drop (ΔG)) is 2.5 times increased under 300 mV through the guide-inserted nanopore compared to the conventional SiN/Si nanopore in the same condition. Finite element simulation is conducted to figure out the origin of ΔG modification, showing that the guide structure produces high ΔG due to the compartmental limitation of ion transports through the guide to the sensing nanopore. Secondly, the translocation velocity decreases in the guide-inserted structure to maximum 80 % of the velocity in the conventional device at 300 mV. Electroosmotic drag formed inside the guide structure, which directly applies to the remaining segment of translocating DNA molecules in *cis* chamber, affects DNA translocation velocity. This work is the first experimental report on the effect of the geometrical confinement to a remnant DNA on both SNR and dwell time of nanopore translocations.

References

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