（様式 5）

指導教員 承認印	

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学位（博士）論文要旨

(Doctoral thesis abstract)

論文提出者 (Ph.D. candidate)	工学府博士後期課程　　生命工学　　専攻 (major) 平成３０年度入学(Admission year) 学籍番号　１８８３１３０３　　氏名　松井　一真　印 (student ID No.)　　　(Name)　　　　(Seal)
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論 文 題 目 (Title)	ソリッドステートナノポア方式ＤＮＡシーケンサにおける ノイズ低減技術の開発

論文要旨（2000 字程度）
(Abstract(400 words))
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
(in English or in Japanese)

Solid-state nanopore DNA sequencing is an attractive third-generation DNA-sequencing method with the advantages of single-molecule and long-read DNA sequencing. A device for nanopore DNA sequencing has a thin membrane (such as SiN) with a nanopore. When a DNA translocates through the nanopore, an ionic current flowing through the nanopore differs in accordance with a convolution of nucleotides. The signal derived from a single molecule was relatively small, and it is necessary to reduce the electric noise. In this research, we developed the method to reduce two major noise components (high-frequency and low-frequency noise) observed in a SiN-based nanopore.

Reducing device capacitance is effective for decreasing high-frequency noise. However, we found that an electric-charge difference between the aqueous solution in one chamber and the aqueous solution in another chamber occurred. For low capacitance devices, this electric-charge imbalance can lead to an unexpectedly high voltage which disrupted the membrane. We identified that a dominant origin of the charge imbalance is static charge on the outer surface of the chamber. Even though the outer surface was not in direct contact with electrolytes, the charge induces high voltage stress on a membrane according to the capacitance coupling ratio of the chamber to the membrane. We elucidated the mechanism for the generation of initial defects and established new procedures for preventing the generation of defects by connecting an electric bypass between the chambers.

A conventional explanation for the low-frequency noise (called as $1/f$ noise) was a transition model between the trapping and detrapping of a single proton on the surface of the nanopore wall. In this research, we report an unexplored phenomenon whereby $1/f$ noise depends on not only protons but also metal ions in the solution, which cannot be explained by the conventional protonation fluctuation model. To interpret this phenomenon, we proposed a new model in which $1/f$ noise was induced by exchange reactions between protons and metal ions occurring on the silanol surface of the nanopore. This model was proven to be valid by confirming that the experimental value of the magnitude of $1/f$ noise for each metal ion was consistent with the calculated value considering the equilibrium constant of the exchange reaction for each metal ion. We also developed a new $1/f$ noise reduction method by suppressing the exchange reaction; the nanopore wall was coated with divalent cations, which lead to prevent the adsorption of other ions because those adsorption affinities are higher than other ions. As a result, we successfully reduced $1/f$ noise with this method.

（英訳）※和文要旨の場合(400 words)