【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Interdisciplinary Science and Engineering)

# Title of Project : Single-Molecule Sequencing Methods via Tunneling Current

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Research Project Number : 26220603　Researcher Number : 40362628
Research Area : Molecular Devices, Single-Molecule Science
Keyword : Single-Molecule Sequencing, Peptide, Tunneling Current, Nanogap Electrode

## 【Purpose and Background of the Research】

Tunneling current is a quantum electric current that is used to identify small differences in the electronic structures of single molecules. In a previous research, we had succeeded in identifying DNA sequences via tunneling currents using nanodevices.

In this project, we aim to develop single-molecule sequencing methods for DNA, RNA, and proteins and establish the scientific principles of these methods. In particular, we will focus on developing methods for detecting modified DNA, RNA, and peptides relevant to disease markers and regulation of expression.

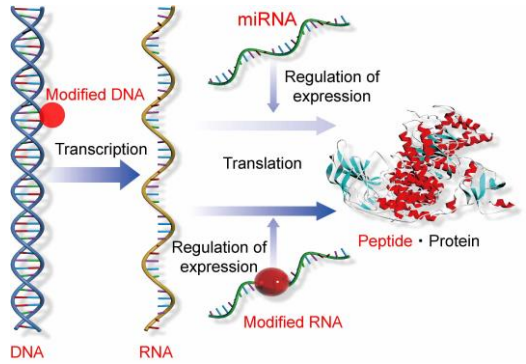


Figure 1 Single-molecule sequencing of DNA, RNA, and peptides, and single-molecule mapping of modified DNA, RNA, and peptides.

## 【Research Methods】

Multi-nanogap electrodes will be developed to read out base molecules of single DNA and RNA and amino acid molecules of single peptides with high accuracies. Algorithms for fragmented sequences of DNA, RNA, and peptides will be developed to determine their full sequences, using information science theories.

Multi-nanogap electrodes integrated with nanofluidic channels will be developed to increase the accuracy of DNA, RNA, and peptide sequencing owing to their ability to read out multiple sequences. Using these integrated nanodevices, where single-molecules perform reciprocating motions between nanogap electrodes, we will develop methods for controlling single-molecule fluid dynamics.

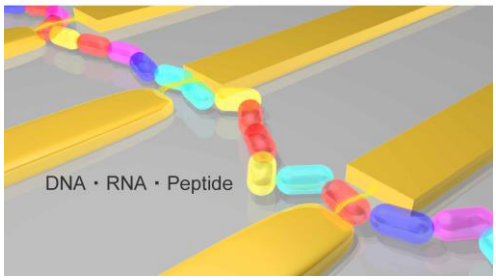


Figure 2 Schematic of single-molecule sequencing using multi-nanoelectrodes.

## 【Expected Research Achievements and Scientific Significance】

Single-molecule sequencing methods for peptides will allow us to identify arrangements of amino acid molecules directly via tunneling currents, with small amounts and high throughput. In addition, detection of modified DNA, RNA, and peptides with single-molecule resolution is expected to reveal the correlation between genetic modifications and the phenomenon of life, while the detection methods can be applied to investigate the relationship between genetic modifications and diseases.

## 【Publications Relevant to the Project】

・M. Tsutsui, M. Taniguchi, K. Yokota, T. Kawai, Identifying single nucleotides by tunneling current, *Nat. Nanotechnol.*, **5**, 286-290, 2010.
・T. Ohshiro, K. Matsubara, M. Tsutsui, M. Furuhashi, M. Taniguchi, T. Kawai, Single-molecule electrical random resequencing of DNA and RNA, *Sci. Rep.*, **2**, 00501, 2012.

【Term of Project】 FY2014-2018

【Budget Allocation】 136,700 Thousand Yen

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