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Article / Book Information

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種別(和文)	論文要旨
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	Porpin Pungetmongkol	指導教員（主）： Academic Advisor(main)	山本　貴富喜　准教授
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The main objective of this research is to realize a label free, high sensitive biomolecules detection and analysis. For this purpose, the three main technical points were implemented to the sensing system 1) electrical impedance measurement 2) micro/nanofluidic system and 3) nanogap detection space. Comparing with other methods, the pure electrical measurement could be conducted with label-free and non-modified surface. This research was utilized the AC impedance which could provide more electronic information; dielectric properties, frequency response. The main device construction is micro/nanofluidic to allow a flow control and high throughput process. Nanogap detection space was integrated to generate high intensity field with maintaining low applied voltage. With high field strength, biomolecule was subjected to electrodynamic forces, which induced the conformational change and motion. The advantage of field inducing electrostatic transition leads to the acquirement of molecular level impedance response. With this format, we could achieve high sensitivity and high resolution electrical measurement of biomolecule in compared with other methods. At first, a nanofluidic device was developed that consists of a nanochannel with fully embedded measurement electrode pairs to directly measure the solution in the transverse direction of the nanochannel. It was successfully to flow and confined sample solution inside the nanogap proximity during the impedance measurement. This sample condition is readily for further analysis and evaluation.

In order to construct a high sensitive biomolecules detection, the impedance measurement of electrolyte were conducted to identify the parameters (ion concentration, channel width and mobility of ions) to create high sensitive system. In here, we could elucidate the disappearing properties of the electric double layer structure. The results demonstrated the electrostatic of ion behavior and electrodynamic of electric double layer with the parameters variation. The electrical characteristic was separated to two distinct behaviors; before and after EDL overlapping. The ion conductivity was strongly depend on the ionic strength and the result was well supported by the Debye- Huckel and Onsanger theory. Whereas, the surface charge limits the resistance of the solution in the nanochannel under the EDL overlapping condition, which is consistent with the measurement results. These results provide better insight into the electrical characteristics of electrolytes in a nanochannel to improve electrical sensing and electrokinetic manipulation of molecules and other nanoparticles in nanochannels.

Finally, the measurement of DNA molecules were conducted and analyzed with different length of DNA from 100, 500, 1000, 5000, 10000bp and lambda DNA (48500bp). As DNA is a biopolymer, the experiments were considering in two dimensions; 1) same number of DNA experiment and 2) same amount of basepairs experiment. We could show an ability to sense biomolecule size and conformation characteristic by electrical measurement (dielectric property and conductive property). From the quantitative analysis, it has been covered all the possible effect on the impedance response as size and conformation effect, total charge carried by DNA, DNA number and the gap size dependence. In this research, the single-molecular level measurement could be achieved in both sensitivity and resolution aspect. As a consequence, we was successfully 1) demonstrated the concept of label free biomolecule detection 2) proved of high sensitivity (single molecule detection) compared with conventional impedance spectroscopy and 3) presented a miniaturized system exploit only femto-molar level of sample concentration This research would be valuable toward universally biomolecules analysis with very high sensitive and high resolution up to single molecular level detection.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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