Electrochemical Impedance Spectroscopy (EIS) for Bio-sensing

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A Lab on a chip (LoC) is integrated several laboratory processes in a device. Recently the LoC type bio-sensor is now attracting interests. The LoC type sensor carries out sample preparation, purification and sensing on a chip, which can reduce the time and sample amount for detection. The result can make it possible to decide rapid diagnostic/prescription. To realize such LoC-type biosensor, simple and high-sensitive biosensing method is necessary.

Electrochemical impedance spectroscopy (EIS) is now commonly used in battery researches and the interfaces among electrodes and electrolyte layer are characterized. This EIS measurement could be applied to interfaces between the electrode and aqueous solutions, i.e. bio-sensors [1]. From electrical circuit point of view, the interface could be interpreted as a parallel-connected capacitance and resistance. The capacitance is from electric charge bilayer and the resistance is from the charge-transfer between an electrode and mediator [2]. When the electrode is modified bio-receptor, the charge transfer resistance (Rct) increases in proportion to biomolecules absorption (Figure1). We are now proving this technique can be applicable to the DNA hybridization detection. In this presentation, we describe the EIS theory and experimental results.

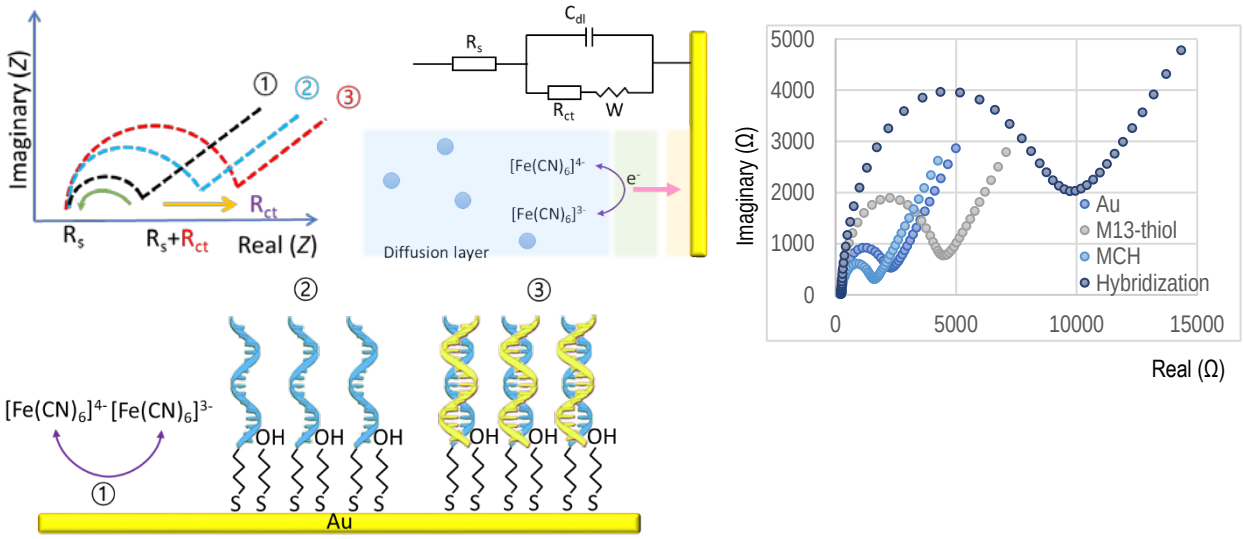

Figure 1. EIS biosensor principle. A gold electrode is modified with probe-DNAs. The sample solution is introduced to the chamber. When complimentary DNAs exist, Rct increases in proportion to the complimentary DNA concentration. The Nyquist plot was obtained by Vac=5mV, 1MHz-0.1Hz.

Reference

[1] Keighley, S.D. et al., 2008, Biosensors and Bioelectronics, 24 (4): 906-911.

[2] Matsishin, M. et al., 2016, Sensors and Actuators B: Chemical, 222: 1152-1158.