Séminaire SATIE

Mardi 16 juillet 2013 à **11h**

Amphithéâtre Chemla (ENS Cachan)

par le professeur **Eishii Tamiya**, de l'Université d'Osaka

« Electrochemical mobile sensors and nanophotonic devices for biomedical diagnosis ».

1. Mobile electrochemical biosensors for point-of-care diagnosis

Biomarkers like genes, proteins and cellular signals can be monitored by electrochemical biosensors. Printable electrodes have advantages in mass productive and disposable applications. Mobile electrochemical detector has been also developed and commercialized by Biodevice Tech. Ltd. Electrochemical DNA detection has been originally developed without immobilization of DNA onto electrodes (*Electrochemistry Commun. 6,337,2004, Electrochem. Acta, 82, 132, 2012*). PCR process can be monitored in real time and applied to detection of actual targets such as pathogens like *Salmonella*, O-157 and *Flu* virus, genetic modified organism (*Analyst 134,966,2009*), origin of meats (*Food Control, 21,599, 2010*) and so on. Microfluidic PCR and RT-PCR chips were useful for rapid detection with our electrochemical DNA sensor method. (*Analyst 136,5143, 2011*).

Gold nanoparticle-antibody can be linked with new electrochemical immunoassay as GLEIA (gold linked electrochemical immunoassay). High sensitive detection of human chorionic gonadotropin (0.36 pg/mL) and insulin (0.1 ng/mL) were reported (*Electroanalysis, 20,14, 2008).* Antioxidative activity in food and amount of residual pesticides are also monitored by redox indicators and printable electrodes. Microbial respiration activity can be monitored by printable electrodes and mobile detector and applied to rapid measurement of microbial viable cells (*Electrochem. Acta, 82, 132, 2012).*

2. Nanophotonic biosensors based on LSPR and SERS

We have studied successfully nano-structured biosensors employing the localized surface plasmon resonance (LSPR) (*Anal.Chem.77, 6976, 2005, Anal.Chem.79, 1855, 2007, ACS Nano, 3, 446, 2009, Anal. Chem. 82, 1221, 2010)*. Photonic plasmon spectra are caused by the refractive index variations that result from the binding of molecules to the metal nanostructures. There are optically detectable parameters in biophotonics and biosensor devices. The bio-sensing of these nanostructures have been examined by label-free monitoring the biomolecular interactions in various flexible formats. Antibody-antigen and DNA hybridization reactions were performed to detect various biomarkers, with the detection limit of picogram levels. The multi array format was constructed by a core-shell structured nanoparticle layer, which provided 300 spots on the sensing surface (*Anal.Chem. 78, 6465, 2006)*. We demonstrated the capability of the array measurement using immunoglobulins, C-reactive protein, and fibrinogen. The detection limit of our label-free method was 100 pg/mL.

A microfluidic biochip based on Ploydimethylsiloxane was used for real-time analysis and rapid detection. DNA and cellular signals from the target cells can be monitored by our system. DNA amplification process (PCR) and monoclonal antibody production from hybridoma cell library can be monitored (*Anal.Chim.Acta, 66,111,2010)*.

Electrochemistry measurements connecting to LSPR chips were successfully exploited in a simultaneous detectable scheme. The binding of melittin to lipid membrane was measured using localized surface plasmon resonance, and the permeability of the lipid membrane was then assessed electrochemically as a function of melittin with the purpose of seeking a novel, sensitive detection system for peptide toxins (*Anal.Chem.80,1859,2008*).

These nanoporous structures were transferred to the cyclo-olefin polymer film surface from the porous mold by a thermal nanoimprinting process. A plasmonic substrate was fabricated by sputtering a thin layer of gold onto this nanopillar polymer structure and the refractive index response in a variety of media was evaluated. Finally, the biosensing capacity of this novel plasmonic substrate was verified by analysis of human immunoglobulin and achieved a minimum detection limit of 1.0 ng/mL. With the advantages of mass production with consistent reproducibility stemming from the nanoimprint fabrication process, our gold-capped polymeric pillars are ready for the transition from academic interest into commercialization systems for practical use in diagnostic applications (*Anal. Chem. 84, 5494,2012).*

Surface Enhanced Raman Scattering (SERS) was also discussed with gold and silver nanoparticles interacting with bio-molecules. Gold nanoparticles were successfully delivered into single cells. Spatiotemporal measurements of SERS fingerprints suggested the dynamic molecular interactions and transformations taking place at different locations with time in cardiomyocytes (*PLoS ONE, 6(8) e22801,2011)*