

Soutenance de thèse

Lundi 17 décembre

14h 00

C2N Site Orsay, salle 44 (P. Grivet)

Qiongdi ZHANG

“ Integration of a polarizable interface for electrophoretic separation in a microfluidic device ”

Jury members :

Ming ZHANG	MCF	Université Paris-Sud - Centre de Nanosciences et de Nanotechnologies	Directeur de thèse
Pierre JOSEPH	Chargé de Recherche	Laboratoire d'analyse et d'architecture des systèmes CNRS	Examineur
Wilfried UHRING	Professeur	Université de Strasbourg - Laboratoire ICube - UMR 7357	Examineur
Philippe LECOEUR	Professeur	Université Paris-Sud - Centre de Nanosciences et de Nanotechnologies	Examineur
Gaëlle LISSORGUES	Professeur	ESIEE Paris	Rapporteur
Philippe BERGONZO	Professeur	University College London	Rapporteur
Anne-Marie HAGHIRI-GOSNET	Directeur de recherche	Centre de Nanosciences et de Nanotechnologies - CNRS	Invité
Antoine PALLANDRE	Professeur	Université Paris-Sud - Laboratoire de Chimie Physique UMR 8000 CNRS	Invité

Abstract :

Medical check-up and throughout diagnostics require multiplexed sample treatments and high-resolution separations. After the separation steps, a sensitive detection of the biomarkers has to be carried out. One way to efficiently separate precious biomarkers from complex mixtures that are currently used by biochemists is the electrophoresis. The electrophoresis takes place to transport molecules under two contributions: the electrophoretic mobility that is directly related to the ratio between weight and charge of molecules and the electroosmotic mobility, which, in short, allows optimizing the analytical resolution of the separation. Most of the time analysts modulate electroosmotic flow (EOF) by adjusting pH of solution, or changing the ionic strength of buffer, or just using surface treatments. All these methods aim to tune the electrostatic charge state of the interface inside the microfluidic channel. However, these strategies cannot lead to real-time surface charge adjustment. Therefore, in our microfluidic device, a dielectric polarizable interface is integrated and aimed to achieve a dynamic control of the EOF. The concept is based on a real-time modulation of the zeta potential at the solid/electrolyte interface at lower voltage by integrating an external gate voltage, permitting a fast and effective control of EOF independently from the electrophoretic field that is applied along the separation channel. Amorphous carbon nitride (CN_x with $x=15\%$) has been chosen to be the dielectric polarizable material. Since the CN_x cannot be deposited directly on glass substrate, two different materials as sticking underlayer were proposed: silicon carbide (SiC) and platinum (Pt). In this work, we studied the behavior of CN_x film deposited on these two different materials for different architectures. Due to poor adhesion between CN_x and SiC, CN_x film delaminated into the liquid electrolyte soon. Compared to SiC, Pt is a good sticking underlayer for CN_x that was found to be incredibly robust. Even after two months in KCl solution, CN_x still adhered to Pt without any delamination. To avoid any faradic loss in the liquid electrolyte or towards the conductive circuitry of the device, we are developing a hybrid architecture with polymeric insulating pads at the two extremities of the CN_x film. We believe this electric/electrically polarizable/polymeric architecture will be the most robust existing polarizable interface for strong and long-term adhesion onto the glass substrate.