SURFACE CHARACTERIZATION TO IMPROVE BIOMOLECULES IMMOBILIZATION IN THE ASPECT OF BIOSENSOR APPLICATIONS

Kamil Awsiuk [a], Katarzyna Gajos [a], Panagiota Petrou [b], Andrzej Budkowski [a], Ioannis Raptis [c]

[a] *M. Smoluchowski Institute of Physics, Jagiellonian University, Łojasiewicza 11, 30-348 Kraków, Poland.*
[b] *Institute of Nuclear & Radiological Science & Technology, Energy & Safety, NCSR Demokritos, 15310 Aghia Paraskevi, Greece*
[c] *Institute of Nanoscience and Nanotechnology, NCSR Demokritos, 15310 Aghia Paraskevi, Greece*

e-mail: kamil.awsiuk@uj.edu.pl

In the presented studies time-of-flight secondary ion mass spectrometry (ToF-SIMS), X-ray photoelectron spectroscopy and atomic force microscopy were employed to evaluate the biomolecular layers built-up on the sensing arms of Broad-Band Mach-Zehnder interferometers integrated on silicon chips [1] as well as to evaluate orientation of proteins adsorbed to surface of promising conducting polymers [2,3], critical for development of bioelectronics and biosensors applications.

ToF-SIMS imaging and micro-analysis was used to examine the protein surface patterns formed with a microarray spotter onto the sensing arm windows of integrated on silicon chips Mach-Zehnder interferometer arrays aiming to determination of bovine κ-casein in goat milk [1]. Uniform molecular distributions are observed on the sensing arm areas after spotting with optimum κ-casein concentration. Use of the optimum conditions for functionalization of chips with arrays of ten Mach-Zehnder interferometers provided on-chips assays with dramatically improved both intra-chip response repeatability and assay detection sensitivity. In addition, subtle differences in chip surface chemical composition between the sequential steps employed in biomolecule immobilization, surface blocking and immunoreaction are revealed by Principal Component Analysis (PCA) of ToF-SIMS results.

Second studies focus on how the surface structure, amorphous for regiorandom poly(3-alkylthiophene) (PT) and semi-crystalline for regioregular PTs, affects the orientation of proteins: rabbit immunoglobulin [2] and streptavidin [3]. Many of bioelectronic and biosensor applications are based on PT conducting and solution-processable polymers, therefore, protein interactions with PT surfaces are critical for development of their bioapplications.

Since ToF-SIMS probes only the outermost layer of protein films, multivariate analysis enables detection of protein orientation. PCA distinguishes between amino acids characteristic for external regions of proteins molecules adsorbed to different PTs. The most important result was the finding that the interaction between protein dipole moment and polymer film plays a significant role in protein orientation..

[1] K. Gajos, M. Angelopoulou, P. Petrou, K. Awsiuk, S. Kakabakos, W. Haasnoot, A. Bernasik, J. Rysz, M.M. Marzec, K. Misiakos, I. Raptis, A. Budkowski, Applied Surface Science, 385, pp. 529-542, 2016
A. Eisenberg, Guide to Technical Editing, Oxford University, New York, 1992
[2] K. Awsiuk, A. Budkowski, P. Petrou, M.M. Marzec, M. Biernat, T. Jaworska-Gołąb, J. Rysz, Colloids and Surfaces B: Biointerfaces, 148, pp. 278-286, 2016
[3] K. Awsiuk, P. Petrou, A. Thanassoulas, J. Raczkowska, Langmuir, 35, pp 3058–3066, 2019