PHYSICAL AND TECHNOLOGICAL SCIENCES

Research Group “Nanotechnas”

Vilnius University

Keywords: *analytical electrochemistry, surface plasmon resonance immunosensors, bioanalytical methods, biosensors, nanobiotechnology, nanoparticles, nanostructured surfaces, biological samples, site-directed antibody immobilization*

Research group activities

Diabetes is a serious health concern causing disability or even death. According to the International Diabetes Federation it is expected that by 2040 number of adults having diabetes worldwide will rise to 642 million. Electrochemical biosensors for glucose monitoring and diabetes management are the most popular among other types of biosensors due to their rapid response, simplicity to operate, long-term stability, miniaturization opportunity, high selectivity and sensitivity, easy fabrication and application in turbid media. Additionally, glucose biosensors received enormous benefits from nanotechnology, concerning the design of new nanomaterials, the integration of nanostructured surface or nanomaterials able to improve biocomponents performances, and the construction of biocompatible and implantable devices for continuous monitoring.

Immunosensors are promising and attractive technique, offering high specificity due to the use of very specific immune molecules, non-destructive approach to sample, simple operation, uncomplicated sample preparation and, most importantly, high sensitivity, especially when different signal transducers have recently been combined to yield low limits of detection. However, in order to achieve the characteristics mentioned above, some important issues have to be resolved, especially related to proper orientation of antibodies. Nowadays, achievements of nanotechnology have high impact on the finding solution to spend important issues occurring in the development of immunosensors.

For many years our research group is focused on:

- Application of different glucose oxidases, various electron transfer mediators, gold nanoparticles of different size or gold nanostructured surfaces and conducting polymers in the development of an amperometric glucose biosensors.
- Development of non-invasive electrochemical and optical glucose biosensors for the detection of glucose in saliva, tears, urine and sweat or other body fluids.
- New method for the site-directed antibody or antibody fragments immobilisation on planar gold surface and gold nanoparticles or magnetic gold nanoparticles.
- Different immunoassay formats (direct, indirect, competitive) and various signal transducers (optical, electrochemical, acoustic) are used in order to achieve the best sensitivity and reproducibility of immunosensor.

Proposal

- Enzymatic and chemical synthesis of metallic and polymeric nanoparticles, electrochemical nanostructurization of conducting surfaces.
- Functionalization of nanoparticles and various surfaces with biologically active molecules using different methods.
- Characterization of synthesized nanomaterials and modified surfaces with atomic force microscope, fluorescent microscope and UV-vis spectrophotometer.
- Registration of specific interactions of biomolecules using surface plasmon resonance and electrochemical equipment.

The group is seeking for partnership with material scientists and engineers for the preparation of new surfaces and nanoelectrodes, with biologist and immunologist for the production of new biologically active molecules, with theorists and mathematics for the modeling of experimental results and verifying of new observations and ideas, with scientific groups using other techniques for materials and surfaces characterization and specific biomolecules interaction registration.

Meet our team

Research group leader - Prof. Dr. **Almira Ramanavičienė**. She is the co-author of more than 145 publications (Clarivate Analytics Web of Science referred journals, h-index 32). During 14 years of research experience she gathered deep knowledge of biosensors and immunosensor development using electrochemical, optical and acoustic signal transducers. She has comprehensive experience in the synthesis of metallic and polymeric nanoparticles and surface modification with different nanostructures, in the site-directed antibody and their fragments immobilization using different methods.

Assoc. Prof. Dr. **Asta Kaušaitė-Minkštimienė**. She is the co-author of more than 36 publications (Clarivate Analytics Web of Science referred journals, h-index 18). Her research is devoted to the study and development of biofuel cells and biosensors. She has comprehensive experience in synthesis and characterization of π–π conjugated polymers and their application for electrochemical biosensors and biofuel cells, as well as in site-directed immobilization of antibodies for surface plasmon resonance immunosensors.

Postdoc Dr. **Inga Morkvėnaitė-Vilkončienė**, PhD student **Laura Glumbokaitė**, Junior researcher **Anton Popov**.

Research outcomes

Most important publications

- **A. Kausaite-Minkstimiene, R. Simanaityte, A. Ramanaviciene, L. Glumbokaite, A. Ramanavicius.** (2017) Reagent-less amperometric glucose biosensor based on a graphite rod electrode layer-by-layer modified with 1,10-phenanthroline-5,6-dione and glucose oxidase. Talanta 171, 204–212.
- **A. Ramanaviciene*, J. Voronovic, A. Popov, R. Drevinskas, A. Kausaite-Minkstimiene, A. Ramanavicius.** (2016) Investigation of biocatalytic enlargement of gold nanoparticles using dynamic light scattering and atomic force microscopy. Colloids and Surfaces A: Physicochemical and Engineering Aspects 510, 183–189.
- **N. German, A. Kausaite-Minkstimiene, A. Ramanavicius, T. Semashko, R. Mikhailova, A. Ramanaviciene*.** (2015) The use of different glucose oxidases for the development of an amperometric reagentless glucose biosensor based on gold nanoparticles covered by polypyrrole. Electrochimica Acta 169, 326-333.
- **A. Kausaite-Minkstimiene, V. Mazeiko, A. Ramanaviciene, A. Ramanavicius.** (2015) Evaluation of chemical synthesis of polypyrrole particles. Colloids and Surfaces A: Physicochemical and Engineering Aspects 483, 224–231.
- **A. Kausaite-Minkstimiene, A. Ramanaviciene, R. Simanaityte, D. Gabrielaitis, L. Glumbokaite, A. Ramanavicius.** (2015) Synthesis of poly(pyrrole-2-carboxylic acid) particles using enzymatic catalysis. RSC Advances 5, 105475-105483.
- **N. German, A. Ramanavicius, A. Ramanaviciene*.** (2014) Electrochemical deposition of gold nanoparticles on graphite rod for glucose biosensing. Sensors and Actuators B: Chemical 203, 25–34.
- **J. Baniukevic, I.H. Boyaci, A.G. Bozkurt, U. Tamer, A. Ramanavicius, A. Ramanaviciene.*** (2013) Magnetic gold nanoparticles in SERS-based sandwich immunoassay for antigen detection by well oriented antibodies. Biosensors and Bioelectronics 43, 281-288.
- **A. Makaraviciute and A. Ramanaviciene*** (2013) Site-directed antibody immobilization techniques for immunosensors. (A Review) Biosensors and Bioelectronics 50, 460–471.
- **A. Kausaite-Minkstimiene, A. Ramanaviciene, J. Kirlyte, A. Ramanavicius.** (2010) Comparative study of random and oriented antibody immobilization techniques on the binding capacity of immunosensors. Analytical Chemistry 82(15): 6401-6408.

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