Molecularly imprinted nanosensor with electrochemical and piezoelectric transduction for the detection of adenosine triphosphate (ATP)

In the fermentation of biomass by yeast, fungi, and microorganisms, utilized in the production of biofuel, a balance is needed between the synthesis of alcohol, proceeding usually under the anaerobic conditions, and the production of adenosine triphosphate (ATP) that is often taking place in the presence of oxygen. To optimize the production of biofuel, a sensitive analytical method for the determination of ATP is needed and highly desired.

The main goal of this project is the development of a new, fast, and inexpensive method for the detection of ATP and evaluation of its utility for controlling the biofuel production process. ATP is the main energy source in cells and an important biomolecule participating in many cellular reactions in living organisms. It is formed in such biological processes as cellular respiration, fermentation, and phosphorylation.

The development of a novel ATP biosensor will be based on molecularly templated polymer matrix films. Fabrication of such films is carried out by simultaneous polymerization and templating of the polymer *in situ* in the presence of the target molecule. The target molecule is then released from the template, e.g. by hydrolysis, leaving specific biomimetic recognition sites in the polymer. Such a templated polymer film offers specificity toward the target molecule, based on the steric fitting, Van der Waals forces, hydrogen bonding, electrostatic interactions, and/or dipolar forces. The use of polymer provides enhanced processibility and scalability. In these studies, novel ATP biosensors with molecularly imprinted films will be synthesized by *in situ* electropolymerization of a polymer in the presence of adenosine triphosphate or adenosine monophosphate (AMP) on the surface of polymer. After hydrolysis and removal of templating molecules, the sensor response to ATP analyte will be tested. The analytical signal enhancement will be explored by employing ATP-capped gold nanoparticles (AuNP@ATP) and uranyl ATP complex (ATP-UO_2) for molecular imprinting. Multilayer sensory films consisting of a basal thiolate self-assembled monolayer (SAM), a film of AuNP network assembled on the SAM, and a top polymer template film with imprinted ATP, will also be investigated to increase the number of recognition sites and enhance the film flexibility.

The measurement techniques to be applied include quartz crystal piezogravimetry and electrochemical voltammetric methods.

The design, construction, and testing of this biosensing device will draw from our experience gained with buried potential barrier piezoimmunosensors, redox-probe and fluorescence-probe DNA biosensors for studies of pesticides and herbicides, multilayer functionalized gold nanoparticle carriers for gene delivery, and resonance elastic light scattering (RELS) studies of biomolecule-capped gold nanoparticle assembly (Stobiecka and Hepel, 2011a, Stobiecka and Hepel, 2011b, Stobiecka et al., 2010d, Stobiecka et al., 2010b, Stobiecka et al., 2007, Stobiecka et al., 2009, Hepel and Stobiecka, 2010, Stobiecka et al., 2010a, Hepel and Stobiecka, 2011c,).

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