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Streszczenie w języku angielskim rozprawy doktorskiej pt. ”Molecule imprinting in molecular biology: from determination of oligonucleotides to synthesis of new biocompatible polymer materials.”

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The present PhD thesis describes devising, fabricating, and characterizing of chemical sensors for selective determination of short AT- or GC-rich oligonucleotides. In these chemosensors, a specially developed new class of nucleobase-containing polymers served as probes, providing sensors recognition capability. For preparation of these polymers, a ‘molecular imprinting in polymer strategy’ with sequence-programmable templates was used. First, dedicated stable electroactive bis(2,2’-bithien-5-yl) functional monomers, each bearing nucleobase (A - adenine, T - thymine, C - cytosine, or G - guanine) functionality, were allowed aligning, in the right order, around a selected template, thus forming a pre-polymerization complex via Watson-Crick nucleobase pairing. Stability of the pre-polymerization complexes of AT-rich template with T and A functional monomers as well as GC-rich template with C and G functional monomers were estimated with the density functional theory (DFT) at the B3LYP level and verified with isothermal titration calorimetry (ITC) experiments. Then, these complexes were potentiodynamically electropolymerized yielding films of the molecularly imprinted polymers (MIPs) deposited on surfaces of conducting transducers. After the polymerization, templates were extracted from MIPs. That way, molecular cavities were vacated, thus exposing the ordered nucleobases on the 2,2’-bithien-5-yl polymeric backbones of the probes designed to hybridize the complementary AT- or GC-rich oligonucleotides. Therefore, the extracted MIP films selectively recognized oligonucleotides with respect to one or two nucleobase mismatches. The templates complete extraction from the MIP film was confirmed by the measurements of X-ray photoelectron spectroscopy (XPS), differential pulse voltammetry (DPV), electrochemical impedance spectroscopy (EIS), and polarization-modulation infrared reflection absorption spectroscopy (PM-IRRAS). Morphology of deposited MIP films was unraveled and characterized with AFM. The MIP films were then successfully applied for selective determination of short oligonucleotides under both flow-injection analysis (FIA) and stagnant-solution conditions using piezoelectric microgravimetry (PM), capacitive impedimetry (CI), or surface plasmon resonance (SPR) spectroscopy. Based on these measurements, analytical parameters of the chemosensors, such as sensitivity, selectivity, and the limit of detection (LOD) were estimated. Kinetic analysis of the analytes interaction with the MIPs provided the values of the stability constant as high as that characteristic for longer-chain DNA-PNA duplexes. Moreover, hybridization efficiency of the GC probe as well as its discriminative capability in Dulbecco's Modified Eagle’s Medium was determined.