Description for the general public

The continuous development of technology worldwide is leading to the implementation of innovative solutions in many branches of science. One of the products of research carried out in recent years is innovative, functional biosensors. These are unique in that they make use of non-standard materials which significantly increase the stability and reduce the costs of the systems produced. Biosensors play the role of highly selective chemical detectors, in which a biologically active sensor material enables the detection of a specified substance in the tested environment. The working and reference electrodes – the so-called processing elements – in a biosensor system enable the proper signal to be transmitted to electrochemical analyzers, which in turn allow the reading of the test results. A significant goal of research related to the improvement of biosensors is to increase their sensitivity, that is, to lower the threshold of detection of analyzed substances. Apart from the biological detection element itself, it is important to develop a solution by which it can be attached in a permanent and stable manner to a support. The progress continually being made in the fields of chemical technology and biotechnology mean that biological detectors, created as a consequence of innovative ideas, now offer high selectivity. One type involves the immobilization of enzymes, which have most of the properties necessary for the construction of an efficient and sensitive biosensor. These advances have made biosensors into a serious competitor to traditional chemical detectors. Thanks to the use of biological materials that offer high selectivity and sensitivity, biosensors are becoming available on the market on a wider scale.

As regards the design of matrices for biosensors, increasing interest is being shown in inorganic-organic hybrid materials. Important inorganic supports include metal oxides (such as OsO_2, RuO_2, Fe_3O_4, IrO_2), whose physicochemical and structural properties may be modeled via a variety of synthesis methods. This makes it possible to obtain multifunctional and specialized hybrid systems. Among organic materials, particularly noteworthy are the biopolymers (including chitin and lignin), which often occur as waste products of production processes, and can thus be obtained at relatively low cost. The proposed innovative functional M_xO_y-biopolymer systems undoubtedly represent an exceptional and innovative combination which opens up many possibilities – for instance, for obtaining multifunctional biosensors that can be used to detect specified substances in the environment. All of these factors have persuaded the researchers submitting this proposal to undertake work with the aim of expanding knowledge in this area.

The main aim of the project will be to synthesize innovative platforms of M_xO_y-biopolymer/enzyme type, and to evaluate their potential application as biologically active materials in biosensors. Comprehensive analysis of their physicochemical, dispersive, morphological and biochemical properties will enable a detailed determination to be made of the potential usability of the new systems. The proposed biosystems will contain selected inorganic oxides and functional biopolymers from the lignocellulose, polysaccharide and biomimetic groups of materials. The platforms obtained will be evaluated to determine how the selected method of synthesis affects their physicochemical, structural and functional properties. A further important stage of the work will involve the immobilization of selected enzymes on the surfaces of these M_xO_y-biopolymer platforms. This will be done using various methods, including adsorption and the formation of covalent bonds. Verification of this stage of the research will be provided by biological tests of the resulting biocatalytic systems, which will determine such properties as their stability and level of enzymatic activity. Finally, selected systems will undergo electrochemical tests using amperometric and potentiometric methods. This is a very important element of the research, being directly linked to the possibility of the systems' being used in particular testing environments. Following preliminary tests, it will be necessary to carry out optimization of the obtained M_xO_y-biopolymer/enzyme systems, taking into account the effect of such factors as pH and temperature, the minimum and maximum limits of detection, etc. The utilitarian aspect of the research will concern the utilization of the obtained materials, with immobilized enzymes, as catalysts in dedicated biosensing processes.

The project will be made possible by collaboration between two units: the Faculty of Chemical Technology of Poznan University of Technology, and the NanoBioMedical Center of Adam Mickiewicz University in Poznan, both of which have a wealth of research experience and a large base of experimental equipment. The high scientific standards represented by both institutions has the potential to lead to significant development and advances in this innovative area of research pertaining to modern technologies.