

## **The mechanisms of bioelectrochemical transformation of petroleum waste products into biosurfactants**

Microbial fuel cell (MFC) is a device, which generates electrical energy with the use of bacteria. Bacteria colonise the MFC electrodes, forming a thick layer called biofilm. Wastewater, several waste products, but also environmental pollutants (such as petroleum products) can be used as a fuel and converted to electric current by bacteria. Biological decomposition of such pollutants in the environment is often facilitated by the presence or production of biosurfactants which increase their availability to microorganisms.

Bioremediation (environmental clean-up) of polluted areas often requires an addition of electron acceptors (for example oxygen) and consumes significant amount of energy. In MFCs in contrast, biodegradation leads to generation of energy, while the robust electrode is used as an electron acceptor and its lifetime may reach decades. Bioelectrochemical stimulation of biodegradation is a novel and uprising trend in science and technology.

In order to take a full advantage of microbial fuel cells in bioremediation techniques however, it is essential to unravel and understand the mechanisms of biosurfactant synthesis and complex interactions at the interface of biosurfactants and the particular components of MFCs. Within the proposed project we will initiate a unique research in order to establish the process of bioelectrochemical conversion of petroleum waste pollutants into biosurfactants. The byproduct of this process is an electrical energy which could be used for internal need of bioremediation process. Furthermore, we will determine the properties and chemical structures of selected biosurfactants and their influence on biodegradation process. Our initial results indicate that microorganisms are capable of transforming organic chemicals into biosurfactants with concomitant generation of electricity. The mechanisms of biodegradation coupled with conversion to biosurfactants, their interactions with the MFC components and the methods of electrochemical stimulation of the process remain unknown.

The interdisciplinary character of the project, international and domestic collaboration with the experts in analytical science, interphase research and metagenomics will allow us to determine the mechanisms which control bioelectrochemically-stimulated conversion of petroleum waste into biosurfactants. Combining the process of biosynthesis and generation of current will allow us to increase the efficiency of microbial fuel cells in biodegradation of insoluble aromatic hydrocarbons. Such an approach has never been used before.

In wider perspective, the outcomes of the research will lead to the development of a novel bioremediation technology, where the pollutants will be both fuel to produce energy and substrate to produce biosurfactants. Their biosynthesis will further help to improve the biodegradation rate. The excessive energy could be spent within the same process of bioremediation to improve its energy efficiency. Practical implementation of the project outcomes will therefore, lead to more sustainable way for environmental cleanup and boost the quality of life in polluted areas.