Crystals with exposed selected crystallographic facets – a new approach to designing anodes for photo-fuel cells

Electricity is one of the most important innovations that science has given to humanity. Electricity is a very versatile and relatively easily controlled form of energy. In a fastly developing world it is an inseparable element of industry and households. At the time of use basically it does not pollute the environment. However, problems appear at the production site.

The demand for electricity is growing every year. Unfortunately, along with this, a significant increase in greenhouse gas emissions and increasing air pollution associated with production methods of electricity are observed. In Poland, electricity is mainly produced based on coal (*ca.* 80% of production). The solution for these problems is to develop energy production methods based on renewable sources and to reduce the consumption of fossil fuels. One of the promising methods for electricity generation are photocatalytic fuel cells. Photocatalytic fuel cells are devices producing electricity converting solar energy and chemical energy of fuels.

Nowadays, fuel cells based on hydrogen and oxygen are the most popular. The problem of these fuel cells is related to the hydrogen generation and the difficulties with its storage. Moreover, materials used in this type of cells are relatively expensive, what leads to high production and operating costs. In contrast to traditional fuel cells, photocatalytic fuel cells are quite cheap in production and require light energy to initiate and maintain the electricity production. Photocatalytic fuel cells are considered as devices utilizing the renewable energy sources for electricity production.

The aim of the project is to study the efficiency of electricity generation using the semiconductor, titanium(IV) oxide, composed of crystals of well defined, tailored shape. The goal is to understand the influence of the exposed facets of TiO_2 crystals on the photocurrents generation. Additional goals are to understand the mechanism of operation and to select the appropriate liquid fuel to ensure effective electricity generation under illumination. Understanding the influence of the shape of crystals on the efficiency of photocurrent generation and mechanism of action will allow to synthesize crystals with an optimal shape and will enable effective working conditions of the photocatalytic fuel cell based on titanium(IV) oxide as a photoanode. The positive results of the project may be a starting point for further optimization of the system and, in future, for the commercialization of an efficient photocatalytic fuel cell.