Construction and studies of a cathode for photoelectrocatalytic hydrogen generation by water splitting

A. Bohdan[1], K. Korona[1], M. Krajewski[1], J. Kucharek[1], W. Pacuski[1], M. Tokarczyk[1], P.Podsadni[3], A. Czerwiński[2], K. Zarębska[2], M. Skompska[2], M. Kamińska[1]

[1]Faculty of Physics, University of Warsaw, Pasteura 5, 02-093 Warsaw, Poland
[2]Faculty of Chemistry, University of Warsaw, Pasteura 1, 02-093 Warsaw, Poland
[3]Faculty of Pharmacy, Medical University of Warsaw, Banacha 1, 02-097 Warsaw, Poland

Hydrogen is one of the most sustainable energy sources – it can be stored, transported, and used in fuel cells or combustion engines without the generation of any pollutants. Therefore, replacing fossil fuels with hydrogen has received intense attention in the last few years. However, hydrogen on Earth is mainly found as a component of molecules such as water and organic compounds. Today, it is produced mainly through steam reforming/gasification of fossil fuels, which not only consumes a large amount of natural gas, naphtha or coal, but also generates CO_2. In the pursuit of CO_2 – free hydrogen technology, electrolysis of water is a promising method.

In this work we present the results of the construction and studies of an innovative cathode for photoelectrocatalytic hydrogen production by water splitting. The oxides and $MoSe_2$ were selected so that the light-excited electrons had sufficient energy to ensure the hydrogen generation reaction. At the same time, the positions of the conduction bands of these materials relative to the vacuum level were such to ensure the transport of light-generated electrons to $MoSe_2$, which can thus act as a catalyst for the reaction.

Tuning the parameters of the oxide and $MoSe_2$ deposition processes allowed us to find a range of technological parameters for which a mechanically stable electrode with promising opto-electrical parameters was obtained. Wide structural and photoelectrical studies were performed. Raman scattering related to characteristic phonon vibrations and Energy-dispersive X-ray spectroscopy techniques were used to identify the deposited materials. SEM images proved successful deposition of the oxide and MoSe2 on the electrode. Photocurrent resulting from the excitation of the constructed cathode immersed in an aqueous solution with radiation from the solar spectrum was also observed. The research carried out so far shows that the constructed electrode is promising in terms of the possibility of using it for photoelectrocatalytic water splitting.

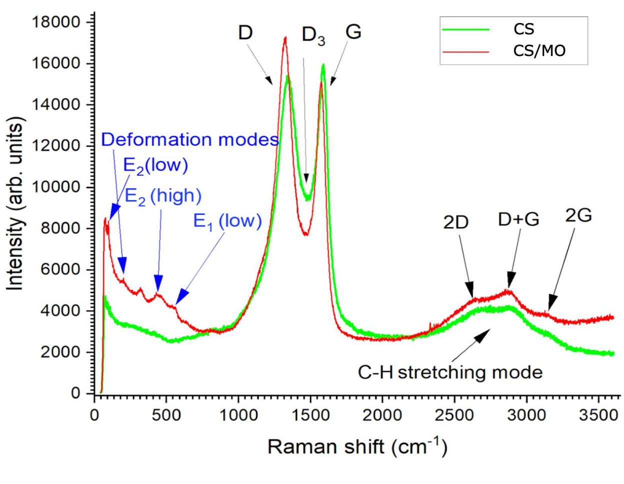

Fig.1. Raman spectra of an electrode (green curve) and carbon/MO structure (red curve). In the low-energy part of the spectrum, peaks from MO are visible.

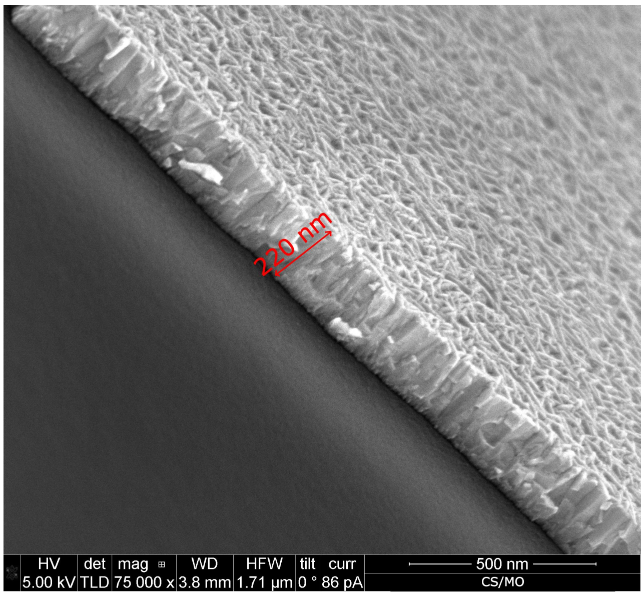

Fig.2 SEM image of the deposited metal oxide layer onto a carbon.