Since concentric carbon nanotubes were discovered in the soot that was generated when the current passed between two carbon electrodes, a lot of works have been conducted in order to obtain nanotubes of various materials – not only carbon but also oxides or nitrides. Of particular interest are titanium dioxide nanotubes formed via electrochemical oxidation of titanium foil followed by calcination to induce phase transformation from amorphous to crystalline one. Due to ordered architecture, highly developed surface area and excellent biocompatibility, TiO_2 nanotubes are used in environmental protection, photooptics, photovoltaics cells, batteries, catalysis and medicine. Unfortunately, their usage in solar-driven processes is limited because of wide bandgap (3.2 eV) which causes that this material is active only in UV light and therefore effective photoconversion processes are possible only in the presence of an artificial light source. Moreover, it should be kept in mind that proposed so far methods of TiO_2 nanotubes modification and hence activation in the visible light, such as e.g. by nanoparticle decoration, often require an additional step to embed nanoparticles into titania matrix or high-temperature and time consuming thermal treatment.

Therefore, the aim of this project is **to obtain TiO_2 nanotubes modified with selected transition metal (e.g. Fe, Co, Ni, Cu, Cr, W) nanoparticles and/or their oxides that are characterized by significantly superior photoactivity in comparison to unmodified material**. A layer of highly ordered titania nanotubes formed in the anodization process will be used as the substrate. Nanoparticles of selected metals and/or their oxides will be produced directly onto TiO_2 nanotube substrates **by means of controlled pulsed laser irradiation** of thin pre-deposited in the magnetron sputtering process metallic layers. As a metal source, chemically pure metal plates will be used. It is assumed that the proper selection of laser working parameters will allow for formation of nanoparticles out of metallic films, controlling of degree of metal oxidation and the permanent embedding of nanoparticles into nanotube layer. Decoration of nanotubes **will be accompanied by a change of their phase from amorphous to crystalline one**.

Modification of nanotubes with selected transition metals and/or their oxides will allow to investigate the correlation between electron structure of metal and the optical, structural, electrochemical and photoelectrochemical properties of obtained materials. For this reason, planned research tasks include among others inspection of the materials morphology using SEM and TEM microscopy, description of optical properties, determination of binding energy of each atom and analysis of the oxidation state as well as determination of the crystal phase. Prepared materials will undergo complex testing using electrochemical techniques, such as e.g. cyclic voltamperometry and electrochemical impedance spectroscopy, that can provide information about electrochemical activity or material resistance. Special attention will be paid to photoactivity measurements when electrode material is illuminated by solar light simulator (illumination will be intermittently interrupted and modulated). It will allow to determine photoconversion efficiency as well as the analysis of recombination processes of charge carriers.

In comparison to the current state of knowledge, the novelty of the planned research covers the use of laser treatment that will allow not only to obtain metallic/metal oxides nanoparticles out of pre-deposited layers but also will ensure the conversion of titania nanotubes phase. Proposed approach eliminates nanoparticles immobilization processes as it is in the case of nanoparticles produced in the colloidal form and does not require prolonged and energy consuming high-temperature calcination in the furnace.

In the last stage of carried research, it is expected that fabricated materials characterized with the highest photoactivity will be used in two model systems: photovoltaic cell and water splitting reactor. The photoconversion efficiency will be determined. The knowledge and know-how gathered during project realization is of great importance for future perspective in which laser processing could be used for modification and inducing phase transformation of materials. Moreover, it is assumed that TiO_2 nanotubes of superior photoactivity can be applied in devices which operation requires illumination by sun light.