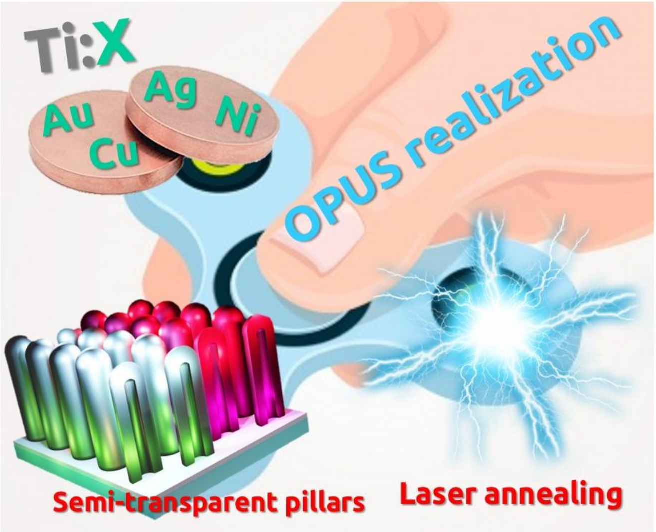
Smart photon management in a photonic structure fabricated via laser irradiation

Nanostructures that can be used in environmental applications, especially related to renewable energy, its conversion and storage, are at the heart of nowadays research world. As most of the works are focused on the solar energy, the possibility of manipulation the passage of light through material is essential. One of the nanostructures that allow to control light guiding are photonic crystals – due to their periodical architecture. Proposed project fits perfectly in this area of science.

This project aims to **investigate smart photon management in semi-transparent nanostructure** that exhibits the extraordinary nature of photonic crystal combined with surface plasmon resonance. It will be based on the laterally separated oxide nanotubes obtained from Ti:X metallic films (X – other transition metal, e.g. gold, nickel, silver, copper) deposited onto the conductive platform. The tubular geometry of material exhibits unique properties, such as very high mechanical strength, large surface-volume ratio and internal active area that facilitates high electron mobility and enhances light absorption. The presence of X transition metal nanospecies incorporated into the ordered scaffold, ensures the occurrence of surface plasmon resonance. Free electrons in metal can act as a resonator additionally giving the boost to material photoactivity. Moreover, formation of the tight cap over the open-ended nanotube via optimized laser treatment will provide interface for the light-material interaction enabling effective light trapping within the empty interior. Therefore, **the synergistic effect of photonic crystal nature, plasmonic phenomenon and laser processing will allow for the nanostructure implementation in optoelectronic devices.**



Scientific work includes the fabrication of several microns thick Ti:X metallic films onto the semi-transparent, conductive substrate, anodization process ensuring formation of ordered nanocylinders, laser processing leading to closing of hollow pillars tops separately and finally detailed morphological, structural, optical and (photo)electrochemical characteristics enabling to describe the efficiency of light harvesting and its dependence on used irradiation conditions. Following that, photoactivity of prepared nanostructures will be tested in two configurations, i.e. when electrode will be illuminated from the back (platform) and front (closed nanotubes) side and when the electrode will be exposed to various lights: whole solar spectrum, only vis or irradiation of particular wavelength. **The experimental results will be confronted with modelling data for the comprehensive description of the road and destiny (recombination processes, photocurrent generation) of light incident onto the nanostructure**.

Gathered in the frames of the project results will greatly increase knowledge in the field of i.a.:

- formation of well separated hollow oxide nanopillars obtained out of Ti:X metallic films sputtered onto semi-transparent conductive platforms,
- laser processing leading to the side selective modification of nanotubes tops,
- light-matter interaction analysis, especially in terms of photoelectrochemistry,
- modelling of optical behaviour of nanostructures,
- description of the role of geometry in light manipulation with special attention put onto nanostructure composition and closed ends of pillars.

Above all, the tailoring interaction between light and nanostructure of complex optical nature can lead to a significant step towards fabrication of novel optical materials with the use of laser radiation and description of phenomena arising during their illumination.