Manipulation of nanoarchitecture – titania nanotubes and their modification with lasers

The time has come to care for our planet. Drastic man-made environmental changes such as the increase in average temperature, air pollution, and vast amounts of plastic in the oceans significantly lower health safety and biodiversity. Following the disturbing effects and growing awareness of society, both social and legislative solutions have been initiated towards minimizing the devastation. Among the solutions, increased focus must be placed upon utilizing renewable energy and material sources for producing fuels and raw chemicals to achieve the EU goal of a low-carbon economy by 2050.

Silicon photovoltaics, hydroelectric, and wind turbines are all mature technologies applied to this grand challenge, but there are limits to their ability to satisfy energy demands. In order to exploit the promise of renewable fuel production, we need to learn how to drive chemical reactions requiring large/concentrated amounts of energy using new, clever designs. Nanomaterials provide several unique properties to approach these challenges. The ability to manipulate both photophysical and catalytic properties based on geometric design can be put to use to obtain efficient sun light driven activity, highly sensing platforms or substrates where a lot of charge can be accumulated.

Currently not only the unique properties are of high importance but also easy fabrication route plays a great role. Among many techniques requiring sophisticated equipment, our materials are based on titania nanotubes or nanodimples that are produced by anodization. The process is carried out in a simple two electrode arrangement and demands only the power supply and optimized procedure. Depending on the applied voltage or electrolyte composition each geometric parameters of the nanotube can be adjusted. Due to the conductivity of Ti substrate, obtained ordered structures can be used as an electrode material without any additional deposition process. Moreover, in our experimental works we use laser radiation for the selective surface modification. Our unique approach enables tight sealing of the open tubes of titania without the destruction of the whole ordered structure. It should be underlined that both methods are highly scalable and can be used to modify substrate of almost any shape and area. It indicates that even laboratory basics works can provide results contributing valuable data ready for the commercial applications.