Photoproduction of hydrogen in biphasic systems with electron donor recycling

It is now more clear than ever that the development of modern societies and survival of human beings depend on the way we can master sustainable source of energy. This project is oriented towards mastering one of them: hydrogen. It is an excellent energy carrier and zero-emission fuel when burned with dioxygen. The use of hydrogen in fuel cells, particularly in the transport sector, will enable future diversification of the energy supply, with greater utilisation of domestic resources, and so reducing dependence on oil imports. Its contribution to clean environment cannot be underestimated as we are facing severe climate change generated by human beings. Application of hydrogen for energy storage seems to be even more important as intermittent energy sources such as wind and solar power have to be integrated into the electrical grid in an enormously large scale. Last not least hydrogen popular use to obtain important substances like ammonia indispensable for fabrication of numerous products cannot be overlooked.

Unfortunately hydrogen cannot be easily collected form atmosphere, because it consist only 0.000055% of H_2. It hast to be acquired from most abundant hydrogen compound - water. Traditional methods of hydrogen production like methane reforming and coal gasification relies on fossil fuels. Still the generation of pure hydrogen by electrolysis frequently depends on the same resources. It is clear that the sources of these fuels are running out. More importantly, societies and politicians start to understand that further use of fossil fuels in some technologies and for electricity generation results in irreversible climate changes and poses danger for our civilization.

The technologies of hydrogen generation based on solar energy start to emerge as one of the simple and sustainable methods. Solar energy may be used for generation of electricity in so called photovoltaic cells, which are already available in the market to power electrolysers generating hydrogen or to drive this process directly. The latter technology is are more than 10 years from readiness and still requires a lot o fundamental studies including search for new systems.

Our project focus on photoelectrochemical systems, where hydrogen is generated at interface between water and oil (organic solvent which does not mix with water). The droplets of oil contain molecules called electron donors. They generate hydrogen at water-oil interface in the presence of sunlight. Since they are consumed during hydrogen generations, they will be regenerated on the electrode being contact with oil. This process will be also powered by light with a help of photovoltaic cells. Oil droplets will be deposited on the electrode surface or will be suspended in water (like in milk) and hit the electrode. In other approach emulsion will be pumped through channels with electrodes for recycling. We expect that few new systems will be constructed and investigated and hopefully they will generate hydrogen with high efficiency i.a. because of regeneration of electron donor. More fundamental knowledge on photoelectrochemical systems generating hydrogen will be also gathered in this project.