## Description for the General Public

Nowadays one of the most important questions is to find alternative fuel that can supply running out conventional fossil fuels. Hydrogen can be found as alternative source of energy mainly due to high energy conversion efficiency, carbon free emission and ability to be produced from renewable sources. Moreover, it can be stored as gaseous, liquid or as hydrides. However, how to produce hydrogen? Surprisingly, commercial hydrogen is produced from fossil fuels with purity around 98 %. One of the ways to produce clean hydrogen (purity of 99.99 %) is photoelectrochemical (PEC) water splitting where hydrogen and oxygen are produced directly from water under the solar energy. The idea of energy production from the water is brilliant, around 1000 $W/m^2$ of solar energy gets to the surface every sunny day and 75 % of planet's surface is covered by water. We have all what we need to produce clean hydrogen. The first demonstration of metal-oxide semiconductors was introduced by Fujishima and Honda in 1972 in which they used n-TiO2 as photoanode. Typical PEC cells are built from photoactive semiconductor material serving as working electrode and platinum electrode as counter electrode. Photons with energy equal or higher than the band gap generate electron-hole pairs in the semiconductor. In case of n-type semiconductor (photoanode), electrons travel to Pt-electrode where reduce $H^+$ into $H_2$, in the same time the holes react with water molecules producing $O_2$. For p-type semiconductor (photocathode), the process is reversed; gaseous hydrogen is produced on semiconductor surface and gaseous oxygen on Pt-electrode. Theoretically, thermodynamic potential equal to 1.23 V is necessary for electrochemical decomposition of water, in fact the required potential is larger due to the energy losses such as recombination losses, electrodes and electrical connections resistances etc. The current research in a PEC cell is to enlarge performances by designing composite consisting of different semiconductors. Up to now, the technology is too expansive and materials degrade too fast to be economically efficient. This project involves fabrication thin layers of eutectic semiconducting hybrids serving as photoelectrodes for photoelectrochemical water splitting by novel technology recently patented in Institute of Electronic Materials Technology. The manufactured eutectics will be investigated in terms of material, structural and photoelectrochemical properties in order to better understand their behavior as well as processes occurring during photoelectrochemical operation. Eutectics provide high crystallinity and sharp interfaces of component phases what decreases recombination rates and increases contact between grains. Moreover, the synergistic effect of two or multiple phases can be achieved. Photoanodes will be investigated in terms of processes occurring during water splitting inside the material and on the surface and in terms of their usability as efficient material for photoelectrochemistry.