Description for the general public.

Main objectives of the project are studies of magnetotransport properties (the dependences of electric resistivity with magnetic field) in nanostructured semiconducting Schottky type junctions with a magnetic single- and double-barrier, i.e. ferromagnetic/semiconductor/ferromagnetic and paramagnetic/ semiconductor/ferromagnetic structures. The two systems selected for studies are: Fe/α-Fe_2O_3/Fe and Ti/TiO_2/Fe, the first one with two magnetic barriers and the second with one.

Magnetic junctions with magnetoresistive effect found their application in electronics, in particular as a reading heads in hard disc drives or as magnetic memories MRAMS. Those junctions are composed of ferromagnetic (FM) layers separated with nonmagnetic (NM) layer of metal or insulator. When the NM layer is metallic a giant magnetoresistance effect (GMR) occurs, when insulator – the tunnel magnetoresistance effect (TMR) is observed. The current flowing through such a junction strongly depends on relative magnetization directions in FM layers – if the directions are parallel then the current is large, if not the current is small. Magnetic junctions with GMR or TMJ effect are the first spintronics elements used commercially in electronic industry. The spintronics is a phenomenon where except electrical charge also a spin charge is used, in other words the spintronics is a spin dependent electronics. Discovery of giant magnetoresistance effect was an important breakthrough in electronic industry and was awarded with Nobel Prize in 2007.

The magnetic junctions with semiconducting layer, like those proposed in this project – ferromagnetic metal/semiconductor/ferromagnetic metal or paramagnetic metal/semiconductor/ ferromagnetic metal, are another type of spin dependent junctions. At the border of metal/semiconductor a barrier is created – the Schottky diode. It is characterized by irreversibility of the current with different voltage polarization. If the metal part is also a ferromagnetic a magnetic Schottky diode is created with barrier for spin current. Therefore using the semiconductor as a spacer for Fe/α-Fe_2O_3/Fe and Ti/TiO_2/Fe junctions the polarity dependent magnetoresistance and current characteristics will be visible (in contradiction to junctions with metal or insulating spacer).

Additionally the junctions will be subjected to nanostructuring that mean they will consist of spatially ordered structures with the sizes of tens of nanometers. The nanostructures will be created with electrochemical process of anodization. Anodized layers of Fe and Ti will form a bowl-like shaped nanostructures embedded on surface of metallic layer. After deposition of top ferromagnetic layer a required junctions will be obtained.

Nanostructures allow for modifications of magnetic properties, like magnetic anisotropy and domain walls pinning. Preparation of junctions with different diameter of bowl shapes will result in set of junctions with different magnetoresistance dependences.

The research activities of Fe/α-Fe_2O_3/Fe and Ti/TiO_2/Fe junctions are focused on studies of magnetoresistance effect and current-voltage characteristics as a function of magnetic field and temperature. Also influence of thickness of the semiconducting spacer and sizes of nanostructures on magnetotransport properties is very important aspect of the project, since by varying those parameters a modification of magnetic properties of junctions will be possible.