Two-dimensional, magnetic surface alloys based on rare earth metals and platinum. Investigation of electronic and magnetic properties with atomic resolution.

Research in the field of magnetic materials is carried out for many years and yet new and interesting materials are found almost every year. Researchers are looking for materials with different magnetic properties, e.g. ferromagnetic, antiferromagnetic, and non-collinear magnetic structures. Already in ferromagnetic materials there is a wide range of properties, e.g. the coercive field can be very small (soft magnets) or very large (hard magnets). The strength of the in-plane or out-of-plane magnetic anisotropy plays a crucial role in magnetic thin and ultra-thin films or multilayers. The temperature dependence of magnetic properties, including the Curie temperature (the temperature below which the material is ferromagnetic), can change with even small alterations in materials' composition or film thickness. Reduction in size also affects the magnetic properties of materials, i.e. bulk properties usually differ from properties of small clusters or ultrathin films. Therefore, the search for magnetic thin films with tailored magnetic properties has been in the focus of research for many years. Binary alloy systems have been very successful as magnetic materials for various types of applications. The combination of two transition metals has most widely been studied, e.g. soft-magnetic *Fe-Ni* or hard-magnetic *Co-Fe*. Combinations of transition metals with rare earth metals also lead to well-known (hard) magnets, e.g. *Fe-Nd* or *Co-Sm*. In addition, combinations of transition metals with noble metals received considerable attention in the past, with *Co-Pt* and *Fe-Pt* as best examples. On the other hand, the combination of rare earth with noble metals is among the least known binary magnetic alloys.

Lately, a new class of magnetic thin films has been discovered, namely *Gd-Au* and *Gd-Ag* surface alloys. In bulk, these alloys exhibit antiferromagnetic order. However, as an ultrathin surface alloy both mentioned systems are exhibiting promising electronic and magnetic properties (ferromagnetism with an in-plane easy axis). A surface alloy is confined to 1 - 2 monoatomic layers and therefore is as thin as physically possible. The robustness of its structure makes it perfect as a magnetic substrate, e.g. for organic molecules in view of molecular spintronics applications. The well-defined structure also makes heterogeneous growth of other materials on top feasible. Moreover, tailoring of the magnetic properties of those surface alloys is possible, e.g. by changing the rare earth metal or by changing the substrate. For instance, replacing *Au* by *Ag* drastically changes the Curie temperature of the alloy system. However, the influence of a substrate with strong spin-orbit coupling, such as *Pt*, is yet unknown.

Within this project, we will perform basic research on the growth and properties of the novel rare earth metal – *Pt* surface alloys. First, we will determine growth conditions of stable 1 and 2 monolayers rare earth metals – *Pt* surface alloys. Subsequently, the atomic structure of the new surface alloys needs to be characterized. We will use surface-sensitive techniques to do this. A combination of low energy electron diffraction (LEED), Auger electron spectroscopy (AES), and scanning tunneling microscopy (STM) will allow us to determine the detailed structure of the obtained surface alloys. As a next step, we will determine the electronic and magnetic properties of these novel systems using STM, scanning tunneling spectroscopy (STS) and spin-polarized STM/STS. In addition, the magnetic properties on a more global scale are planned to investigate by X-ray magnetic circular dichroism method employing synchrotron radiation. All of the experimental results will be supported by theoretical calculations.

In summary, the project addresses the preparation and characterization of novel 2D magnetic systems, which are very important for the further development of nano-spintronics on one hand, as well as for the understanding of basic concepts of magnetic interactions within well-ordered single, or double atomic layer systems consisting of rare earth and *Pt*.