CIC nanoGUNE
nanoscience cooperative research center

SUMMER INTERNSHIPS 2016

TITLE: Magnetism and the Atomic Lattice Structure

DESCRIPTION (Objectives, tasks, materials, equipment…):

In the solid phase, atoms typically arrange in periodic lattice structures, also called crystal structures, to minimize their overall energy. The corresponding physical properties of solids now depend on the exact lattice structure. This is simply the result of the Quantum Mechanical rules that describe the "quantum" state of interacting electrons in large systems, because the overlap of their wave functions is controlled by the distances and the arrangement of the atoms in such a lattice. Thus, all relevant materials properties such as conductivity or magnetism can be modified by changing the atomic lattice. In practice, however, this is difficult to do because atoms have preferred arrangements and distances, which is the reason why solids are nearly impossible to compress.

However, there is an elegant way to change inter-atomic distances and orient atomic lattices in a specific way. This can be accomplished by simply depositing material A on top of a substrate made from material B and thus forcing the atoms of type A to form an atomic lattice given by B, a process, which is called epitaxy. In this way, one can produce a new material that is made out of atoms A, but has very different properties, because its interatomic distances and crystal orientation have been modified or designed. With respect to magnetism, this now has the consequence that the electron spins and their associated magnetic moments like to align in certain macroscopic sample directions, because they correspond to specific lattice orientations that minimize the total energy of the magnetic film. This orientation dependence is called anisotropy and it is one of the most important properties of magnetic materials, also in terms of technical applications such as data storage or wind converters.

The main goal of the project is to fabricate magnetic films, in which the atomic lattice is changed and then study, in how far magnetic properties are also altered. By means of modern fabrication techniques and tools, such as nanoGUNE´s Ultra High Vacuum Sputter deposition system, one can produce novel materials, in which magnetism is altered by changing the atomic lattice with extremely high precision.

SUPERVISOR: Andreas Berger

SUITABLE FOR: physicists, materials scientists, engineers, chemists