Materials for antiferromagnetic spintronics

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Analogously to modern electronics and its relation to the electric charge, spintronics aims at harnessing the spin degree of freedom. A precondition is existence of spin-involving physical phenomena that can be practically utilized, and availability of a suitable material which makes it possible to fabricate devices. For a long time ferromagnets seemed to be the natural material to accommodate and exploit the spin-dependent effects. However, some of the fundamental properties of ferromagnets turned out to severely limit their applicability. This concerns in particular their limited operational speed (due to slow magnetic dynamics), their sensitivity to perturbing magnetic fields, and their limited integration density (due to stray magnetic field).

Antiferromagnets have long been regarded as useless because of the prohibitively strong magnetic fields required to control their magnetic state. Recently, a new mechanism has been discovered capable of reorienting the magnetic order in an antiferromagnet with a special crystal symmetry by electric current [1]. This breakthrough was followed by a boom of interest in spintronics based on antiferromagnets. Institute of Physics of the Czech Academy of Sciences plays a major role in this research.

So far, tetragonal semimetallic CuMnAs represents a key material in the antiferromagnetic spintronics. It is grown in a thin-film form by technology of molecular beam epitaxy. Whereas pure stoichiometric CuMnAs has been intensively studied and its properties and optimum growth protocols are known [2], other members of the I-Mn-V family remain virtually unexplored. **Aim of the proposed PhD project is to synthesize these materials using molecular beam epitaxy, and to study and optimize their properties with respect to spintronic functionality.**

Successful student is expected to get familiar not only with our MBE growth systems, but also with other thin-film fabrication methods (e-beam evaporation, magnetron sputtering), material characterization methods (SEM, TEM, X-ray diffraction), device fabrication (optical and e-beam lithography) and basic electronic transport characterization. The project is a part of an extended international collaboration, therefore we expect active participation in measurements in various laboratories abroad.

We offer a full-time PhD-student position in the Institute of Physics of the Czech Academy of Sciences.

Prerequisite knowledge: basics in quantum mechanics and solid-state physics, computer and experimental skills, a good knowledge of English

[1] P. Wadley et al.: Electrical switching of an antiferromagnet. Science 351, 587-590 (2015)
[2] F. Křížek et al.: Molecular beam epitaxy of CuMnAs. Phys. Rev. Materials 4, 014409 (2020)