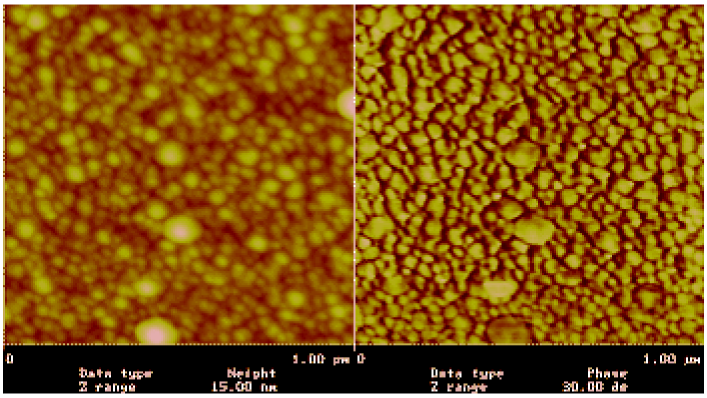
Granular structures

Magnetic grains embedded in an insulating matrix exhibit magnetoresistance (MR) as well as single electron tunneling effects. This effect is very useful for producing an enhanced MR for higher sensitivity sensors



Half-metals

A half-metal is a solid with an unusual electronic structure. For electrons of one spin orientation it is a metal, but for the other spin orientation it is a semiconductor or insulator. These materials provide a natural source of ~100% spin-polarized current which is potentially very useful. The emerging science of spin electronics seeks to exploit the two separate spin channels in increasingly sophisticated electronic devices. The idea is that half-metallic electrodes can act as sources of spin-polarized electrons, and as magnetically-controllable spin filters. So far these expectations have not been fully realized because of various experimental challenges. Our goal at ISML is to solve some of the problems relating to the fabrication of spin polarized devices based on half metallicity. We are developing techniques for synthesizing half metallic films. The magnetoelectronic properties of films synthesized are being investigated and optimum deposition conditions established. Nanostructured half-metallic elements are also being fabricated using lithographic techniques where lateral confinement will give rise to a wide range of magnetic and electronic behavior. Lastly, memory cells for magnetic random access memory are being fabricated using highly spin polarized half metallic materials.

Zinc-blende half-metallic ferromagnets

It is highly desirable to explore new half-metallic ferromagnetic materials which are compatible with important III-V and II-VI semiconductors. Although zincblende phases of MnAs, CrAs, and CrSb have been successfully fabricated as nanodots, ultrathin films and ultrathin layers in multilayers, it has not been possible to grow the zincblende half-metallic ferromagnetic phases as high-quality layers or thick films. This is due to the metastable zincblende phases in these materials are high in energy than the ground-state nickel-arsenide phases. On the other hand, it has been predicted theoretically that CrTe and CrSe in the zincblende structure are excellent half-metallic ferromagnets with wide half-metallic gaps (up to 0.88 eV). These materials are compatible with the binary tetrahedral-coordinated semiconductors and also not only low in energy than the corresponding ground-state phases but also mechanically stable against structural deformations. Thus the know-how on the construction of these materials is important since they combine half-metallicity, a high Curie temperature ($T_c > 400$ K), and coherent growth on semiconductor substrates. Our objective is to grow these materials using molecular-beam epitaxy in the form of films and layers thick enough for spintronic applications.