Thin Film Growth at the NHMFL

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Introduction

A thin film growth facility is being set up at the NHMFL. This facility will be mainly dedicated to the growth of complex oxides. Strongly correlated electron systems are of interest because of their extreme sensitivity to minor changes in the crystal lattice. Thin film growth and strain will allow the creation of materials with artificially engineered structures that cannot exist in nature. It is well known that the application of epitaxial strain can be used to control the lattice and the functional properties in a wide range of materials. Indeed, recent studies have shown that the application of strain can control and/or enhance a variety of scientifically and technologically important properties such as magnetoresistance[1], ferroelectricity and multiferroicity[2-4]. Examples of projects that the group is currently pursuing are,

- Hexagonal ferrites/manganites: tuning multiferroicity in hexagonal systems by way of epitaxial strain and chemical substitution. Construction of a structural, magnetic and piezoelectric phase diagram of these strain stabilized hexagonal structures.
- Frustrated magnetism in pyrochlores: controlling frustration in pyrochlores by imposing epitaxial strain. The geometrical frustration in these materials is directly linked to spin ice formation and the emergent novel magnetic monopoles that are expected within this class of materials.
- Using strain and complex heterostructures to engineer artificial materials with engineered band gaps and large impact ionization rates ideal for the use in improved photovoltaic devices.

Pulsed Laser Deposition

Pulsed laser deposition (PLD) [5] is a technique that is widely used for the growth of high quality epitaxial thin films. In this technique pulses of an excimer (wavelength: 248 nm) laser are focused on a pressed pellet of the material of interest, which is mounted in a chamber under continuous flow of a process gas such as oxygen or argon. The heating of the target due to the laser spot results in the formation of a plasma plume containing target material species. The plume is directed towards a substrate which is mounted on a heater and kept at constant temperature usually in the range of 600 – 1000 °C. The film growth (i.e. surface roughness, type of growth and film thickness) can be monitored using RHEED (reflection high energy electron diffraction). This technique is also extremely well suited to alloy materials (mixing using multiple targets) and to grow complex multilayers of different materials. Hence, investigation of emergent behavior at interfaces between complex materials is within our capabilities. The PLD system is designed and is expected to be brought online in the summer of 2015.

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References

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