QPhysics AT QUEENS COLLEGE

Colloquium Notice

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Pulsed laser deposition and molecular beam epitaxy of multifunctional oxides

The unparalleled variety of physical properties of oxides holds tremendous promise for future applications. Oxides exhibit the full spectrum of electronic, optical, and magnetic behavior. For example, insulating, semiconducting, metallic, high temperature superconducting, ferroelectric, piezoelectric, ferromagnetic, and non-linear optical effects are all contained within one structurally-compatible family. Integration of oxides with semiconductor devices is expected to enhance device functionality and can lead to the development of faster, smaller, and more power efficient devices.

Due to the difficulty in customizing the structure of oxides and oxide heterostructures, many useful properties remain undiscovered and unexploited. Numerous attempts to synthesize metastable oxide structures by conventional solid-state techniques have failed. A non-equilibrium growth technique is necessary to stabilize these phases. In our laboratory we use two techniques to grow oxide films and heterostructures.

In the first technique, molecular beam epitaxy (MBE), molecular beams of different metals are generated in the effusion cells pointed towards the heated single crystal substrate. Computer controlled shutters, positioned in front of each of the effusion cells, allows to terminate the flux reaching the sample within a fraction of a second while crystalline arrangement of the surface of the film is monitored by reflective high energy electron diffraction. This provides nanometer-scale layering control and allows us to grow customized structures in which the sequence of atomic layers is changed at will. Thus, the full spectrum of the electronic properties of oxides is combined in novel epitaxial heterostructures. In the second technique, pulsed laser deposition (PLD), a target made of selected elements is ablated with the ultra-violet laser. The plum of material condenses on the single crystal substrate resulting in a thin film growth. Although not as precise as MBE, PLD offers a rapid means of preparing custom-made stacks of single crystal films. Using these techniques we investigate growth of high crystalline quality ferroelectric $Ba_xSr_{1-x}TiO_3$ films and other members of the $Sr_{n+1}Ti_nO_{3n+1}$ ($Ba_{n+1}Ti_nO_{3n+1}$) Ruddlesden-Popper series. Our final goal is the epitaxial growth of these materials on GaN/SiC heterostructures and demonstration of novel devices such as tunable filters and phase shifters.

Monday
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Starts at 12:15 PM
Coffee at 12:00 PM
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