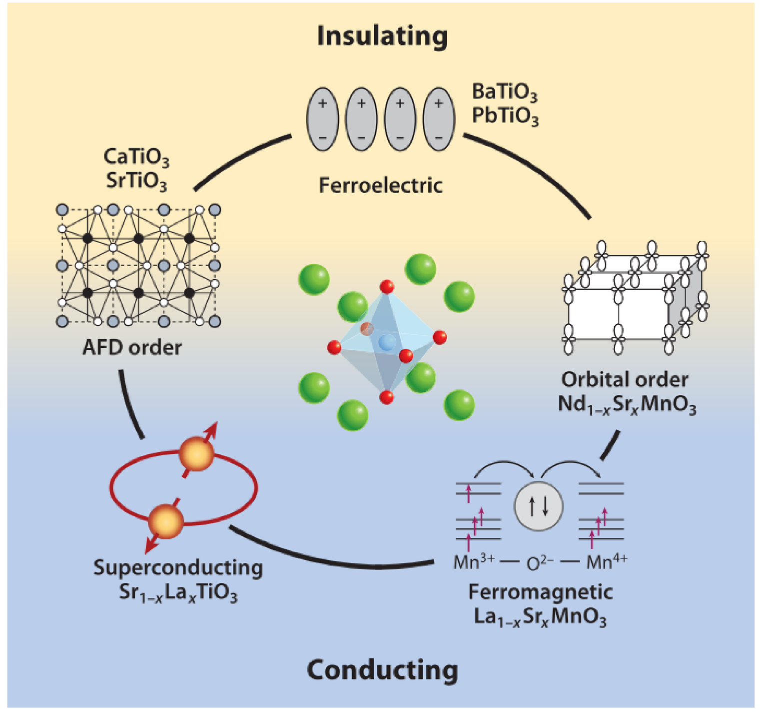
Oxide Interface Physics

Gabriele De Luca[1], Umar Bashir[1], and Marta Gibert[1]

[1]Institute of Physics, University of Zurich, Switzerland.

Why oxide thin films and superlattices?

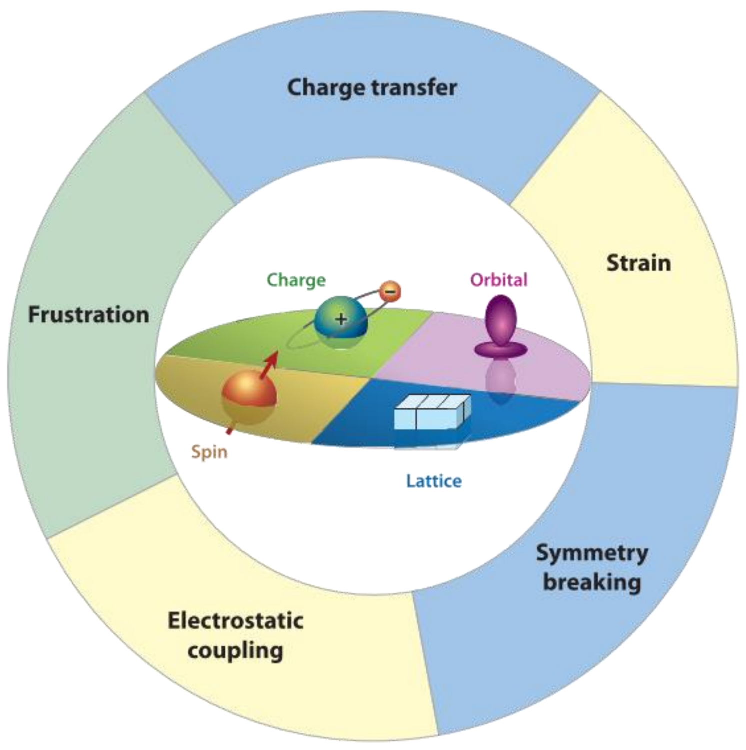
- Electronic correlations in transition metal oxides give rise to exotic properties:

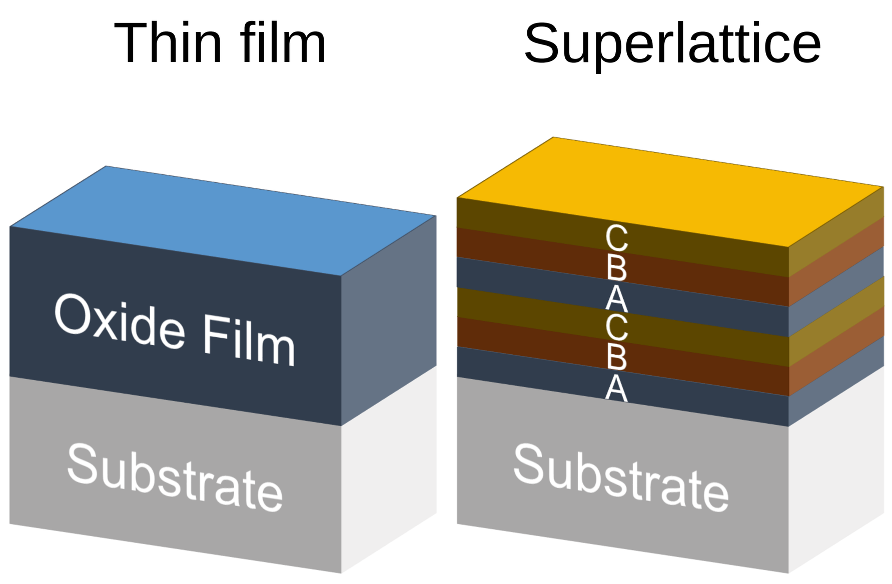


- (Anti-)Ferroelectricity
- (Anti-)Ferromagnetism
- Multiferroicity
- Orbital ordering
- Superconductivity
- Metal-to-insulator behavior
- Colossal magnetoresistance
- Mott insulating character
- Memristive switching
- Jahn-Teller distortions
- Etc...

Zubko et al., *Ann. Rev. Cond. Matt. Phys.* **2**, 141 (2011)

- Growth of oxide heterostructures (thin films, superlattices) enables further tuning of oxides' functionalities and also allows novel material properties to be found!



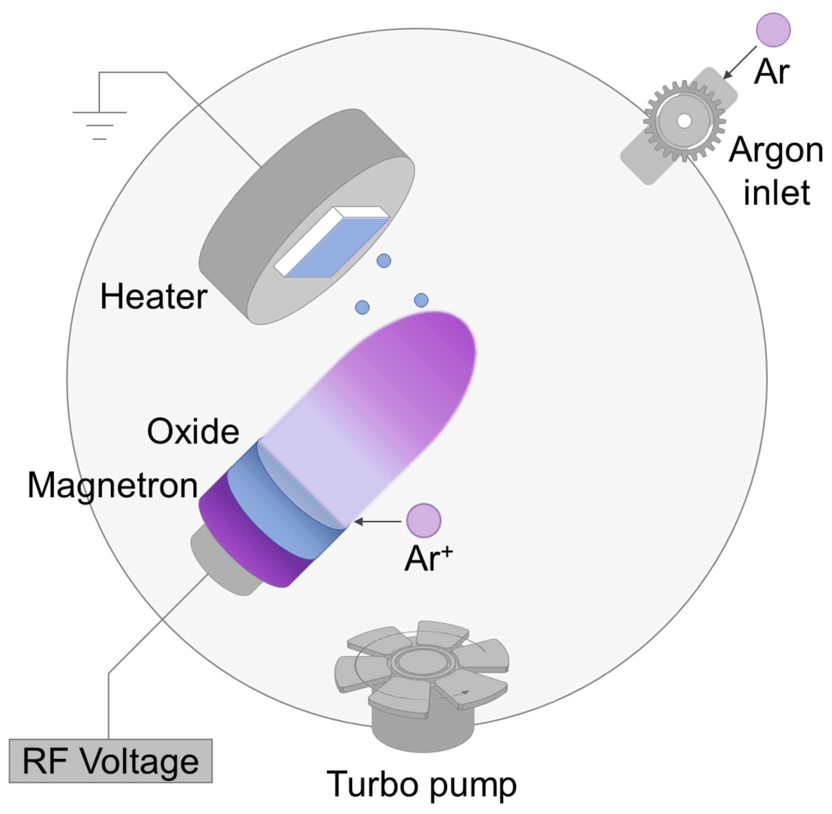


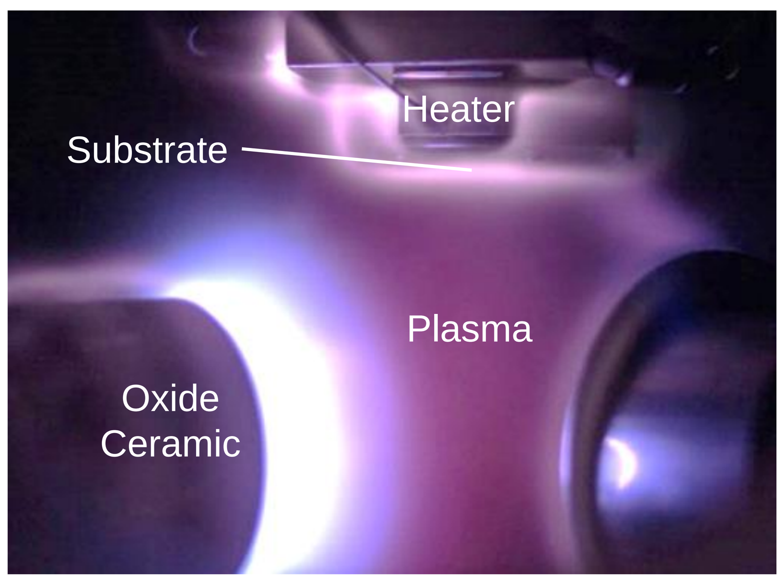
Complex Oxide Growth

Our laboratories

Structural Characterization

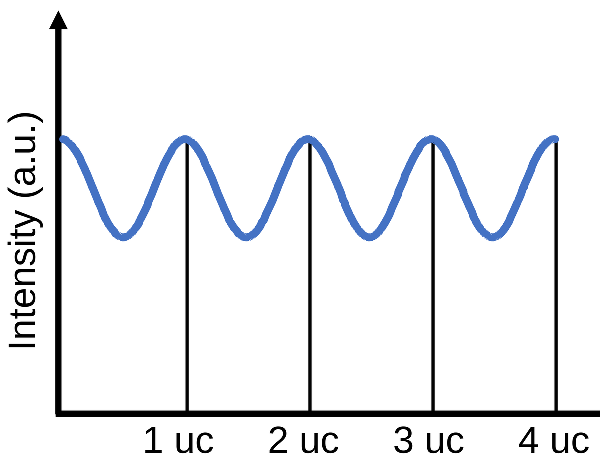
By Radio Frequency (RF) off-axis magnetron sputtering

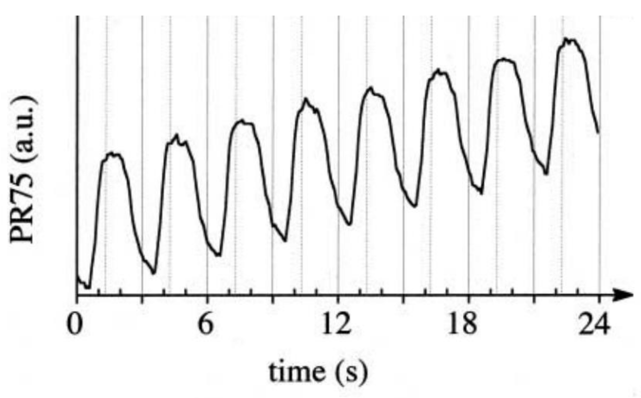




Off-axis geometry increases crystalline quality

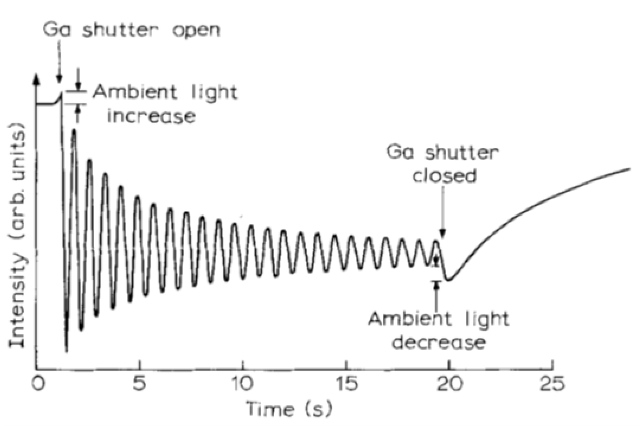
Real-time (in-situ) characterization





Optical reflectance

Dietz, *Mat. Sci. Eng. B* **87**, 1 (2001)

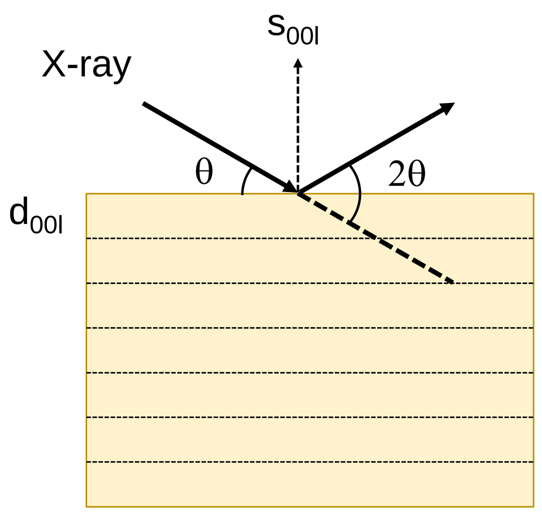


Electron diffraction (RHEED)

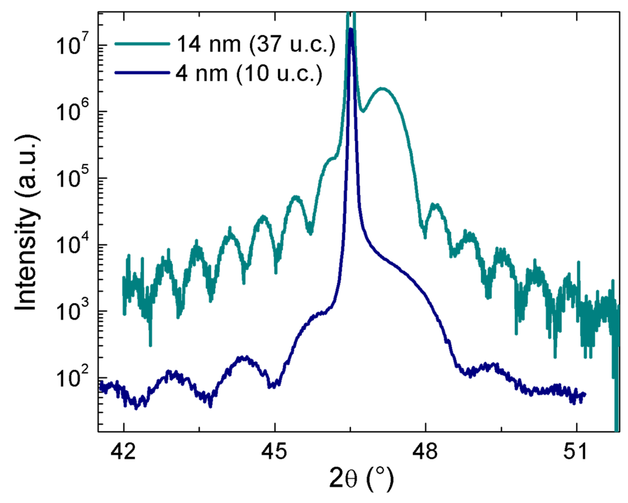
Neave et al., *Appl. Phys. A* **31**, 1 (1983)

To check the crystalline quality of the heterostructures

High resolution X-ray Diffraction (XRD)

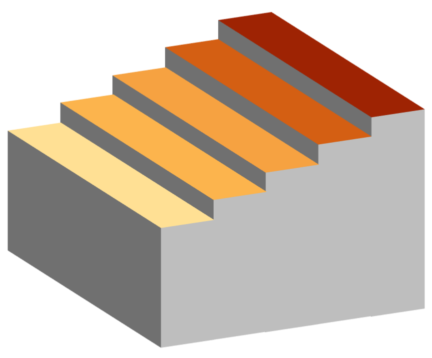


Lattice periodicity in reciprocal space

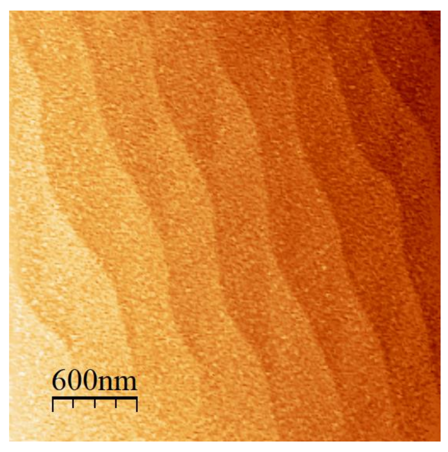


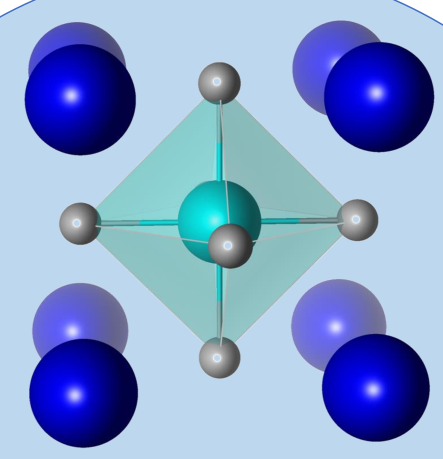
Fringe oscillations related to different film thickness

Atomic Force Microscopy (AFM)



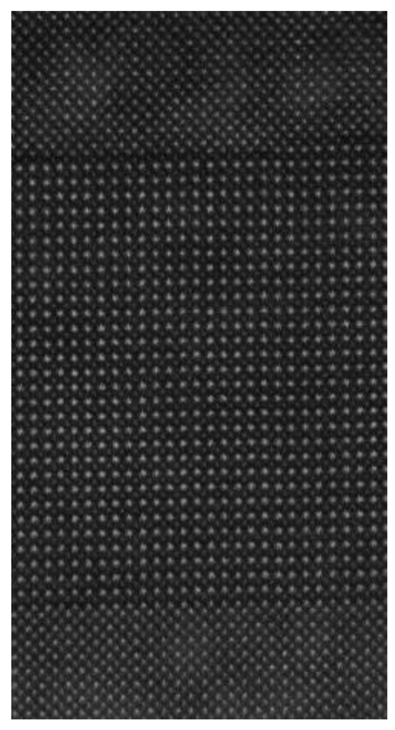
Atomic steps (~4Å high)





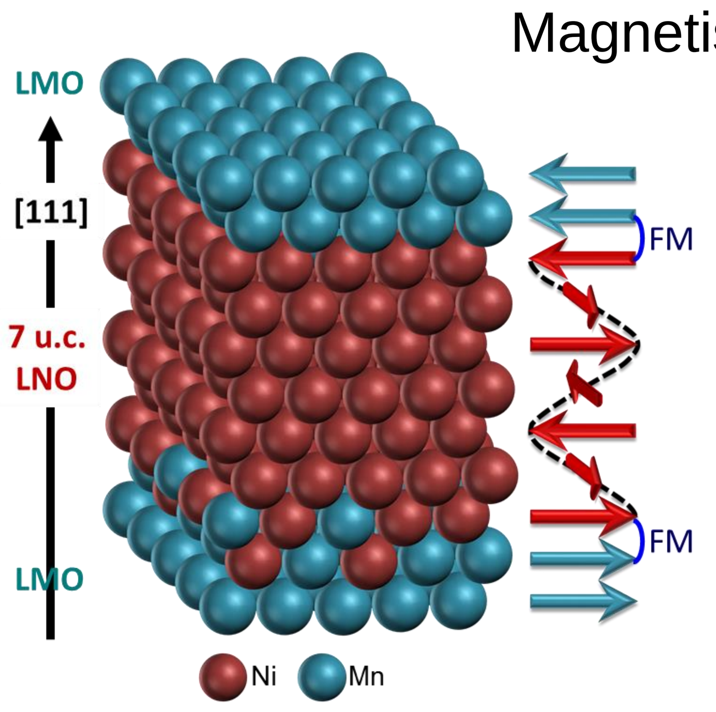
Perovskite (ABO_3)
A = Rare Earth
B = Transition Metal
O = Oxygen

Scanning Transmission Electron Microscopy (STEM)



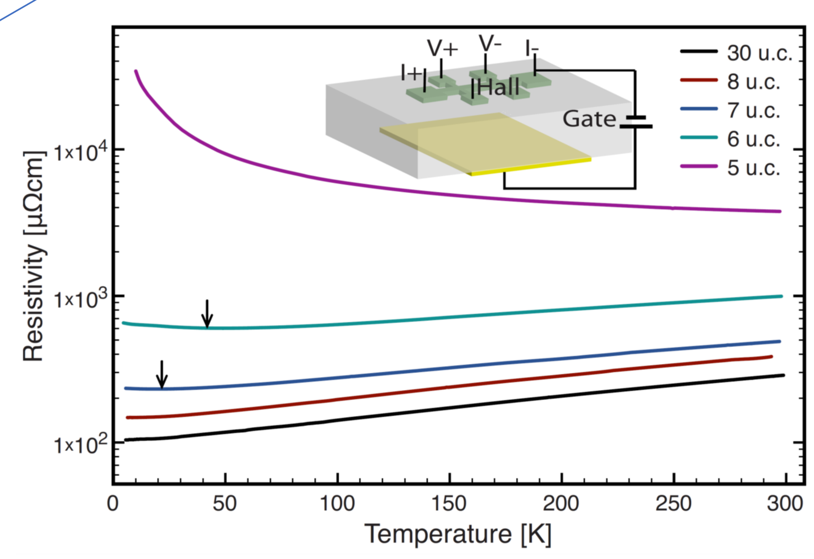
Oxide interfaces resolved with atomic resolution!

Magnetism



Spiral magnetic ordering induced in $LaNiO_3$ (LNO) when grown in superlattice

Transport

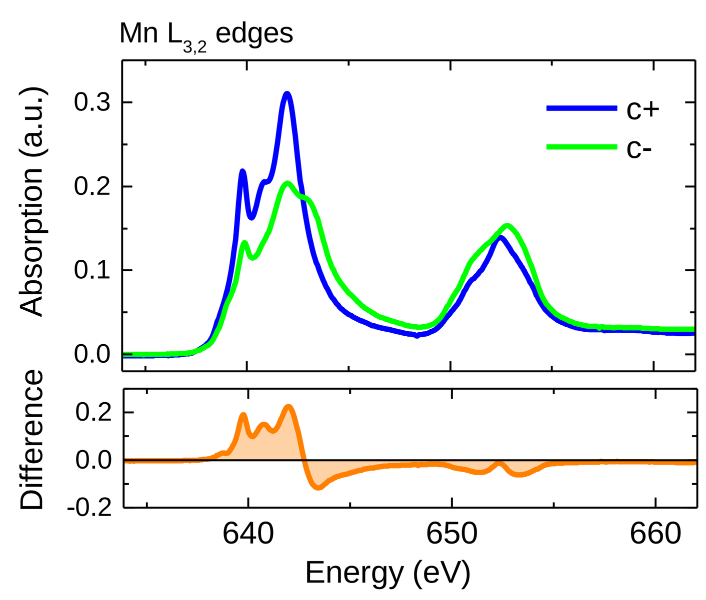


$LaNiO_3$ is conductive in bulk

Thickness-driven metal-to-insulator transition in $LaNiO_3$ films

Scherwitzl et al., *Phys. Rev. Lett.* **106**, 246403 (2011)

Synchrotron



X-ray Absorption Spectroscopy (XAS)

Circular Dichroism (XMCD) gives elemental-specific (Mn) information on magnetic moment

Electronic properties