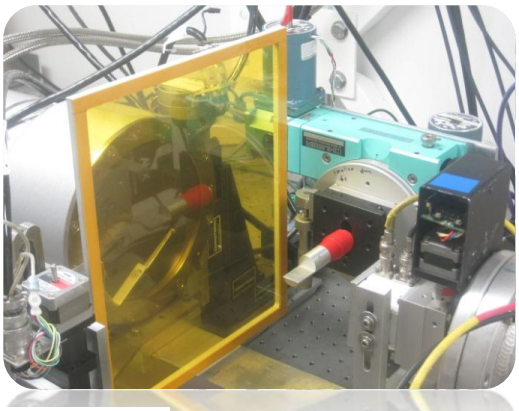
Beamline 1-4 Sample Environments: Goniometer



Device: Huber 410 goniometer

Use: Grazing incidence SAXS characterization (GISAXS) of thin films on substrates

Capacity: Drivable in X, Y and Θ. Finest available step size in Θ = 0.09°. Does not have temperature controlled environment at this time

Showcase Project: Transition Metal Oxide Films for Resistance Switching

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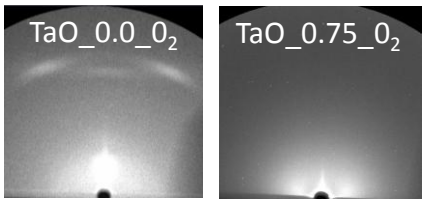
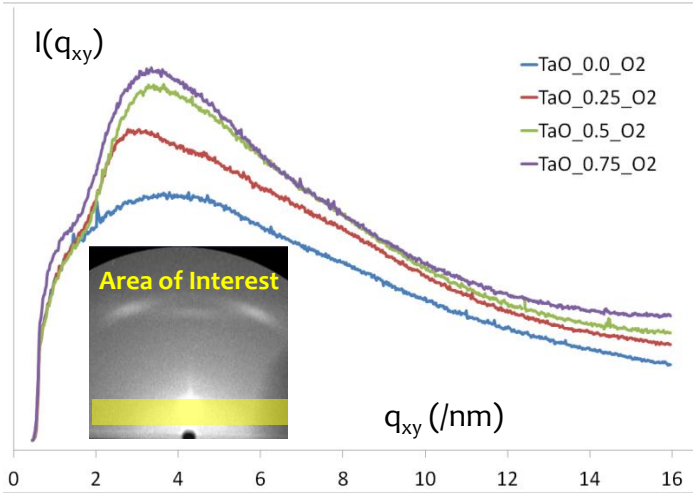
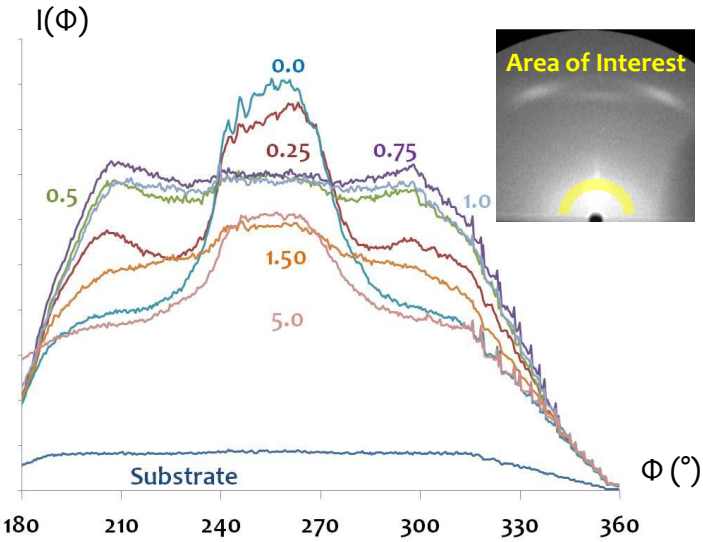
Metal-Oxide-Metal (MOM) thin films are desirable for their resistance switching behavior for computation elements and emulating neural synapses. Oxygen rich/metal poor regions yield high resistance properties and vice versa. Transport may occur by hopping or percolation between charge centers in nanoscale metallic clusters, e.g. $Ta0^+$ clusters within insulating Ta_2O_5.



Films with no O_2 treatment uniquely show features at 4.5Å and 5Å, from the metallic lattice.





Radial reduction of 2d GISAXS diffraction patterns (above) shows the development of $Ta0^+$ features with a correlation length ~2 nm in the films. It also shows that increasing O_2 treatment during development leads to a more pronounced registry of the clusters in the x-y plane.

Meridional scattering peak in Φ-dependent GISAXS reduction (left), associated with $Ta0^+$, decreases monotonically with increased O_2 treatment. At intermediate levels between pure metal Ta and stable oxide Ta_2O_5 order is preferentially transferred to the x-y plane. As the Ta^{2+} and Ta^{4+} ion clusters form a nanoscale structure throughout the film.