Millis Boulder II

Discussion so far: - surfaces (ill controlled)

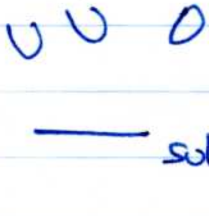
QW: How "passivate" a TMO surface

- speculation

Rest of lectures: superlattice. Apparently better controlled system

Ohtomo, Muller Grazul Hwang. Nature 419 378 (2002)

"Oxide epitaxy" = "careful pulsed laser deposition"

Idea 

Shoot calibrated "puffs" of ions at substrate, under appropriate oxygen pressure. Monitor result by high class scattering

- Can grow many "materials by design"

So far: mainly studied variants on "ABO_3" perovskite structure.

- B site: simple cubic lattice. Latt. par ≈ 4Å
- O : in between each pair of B's
- A : body center of B cube

Typically: B site: electronically active

A site: controls carrier conc. on B

Simplest superlattice: change only A

001 Superlattice: pick 1 cubic axis. Alternate A site:

Ohtomo et. al. $(SrTiO_3)_m / (LaTiO_3)_n$
Band insulator: Ti d^0 "Mott" insulator: Ti d^1

Advantageous structure: need only keep La/Sr in place.

TEM image: Thinned sample. Avg over ~1000Å

- Interface appears v. flat
  Qn: How much local disorder (Sr/La exch) there

- Qn Charge: Sr Sr La La La Sr Sr
  Ti Ti Ti Ti Ti Ti
  0 .5 1 1 .5 0

~~each~~ if O ~~all~~ stoichiometry good
each La ⇒ 1 e^- ⇒ 3 e^-.
Where sit.? Natural Guess: edge of La region: ≈ .5 e^-

Obvious questions: how wide is edge
how thick must you make central region to get ~
what can you get edge to do?

TEM-EELS : Inelastic spectrum corr. to transitions from Ti L edge to unocc Ti d stat
↳(?)

~~Exc~~

(⇒ inverse photoemission + excitonic correct (int. bet. core hole ~~m~~ & el. in unocc. state)

Idea: diff Ti valence ⇒ diff. occ Ti d-states
⇒ diff final state energies
(⇒ differences in spectra large cf electronic hopping time. Will see explicit ex later)

Found (for these lattices): $n\,Ti^{3+} = n\,La$

Also: meas R_{xy}: $2/3\ e^-/La$. Qn: some carrier trapped
? Compensation