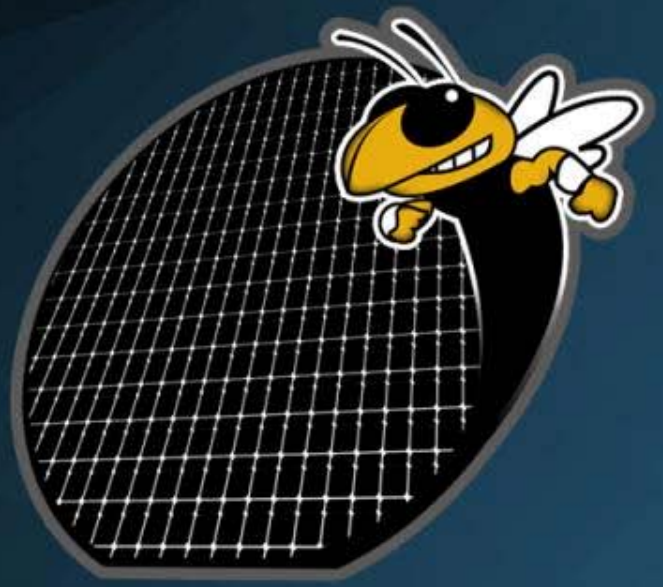
ALD
at Georgia Tech IEN



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NNIN

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Cambridge Nanotech
Fiji F202 ALD

- Dual chamber
  - **Right**: oxides/nitrides
  - **Left**: metals (& oxides backup)
- Plasma/Thermal
  - 300W / up to 500C (chuck)
- Manual load-lock
- 10 precursor ports
  - Oxides: Al_2O_3 HfO_2 ZrO_2 ZnO TiO_2
  - Nitrides: TiN AlN HfN ZrN
  - Metal: Pt

Fig 1. **Plasma ALD**, installed Aug 2010

Home-built thermal ALD

Fig 2. **Home-built ALD**

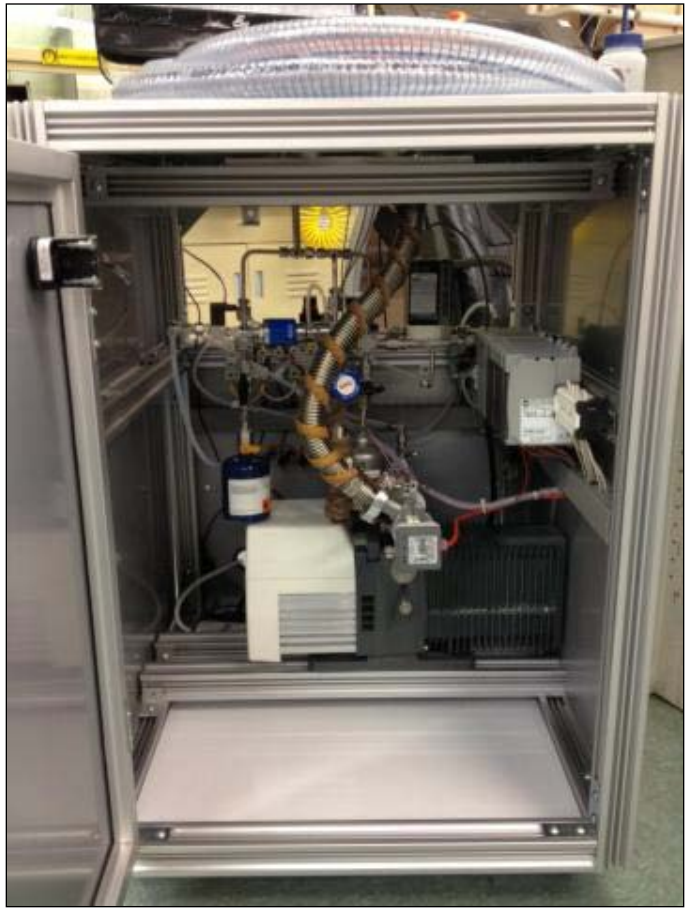
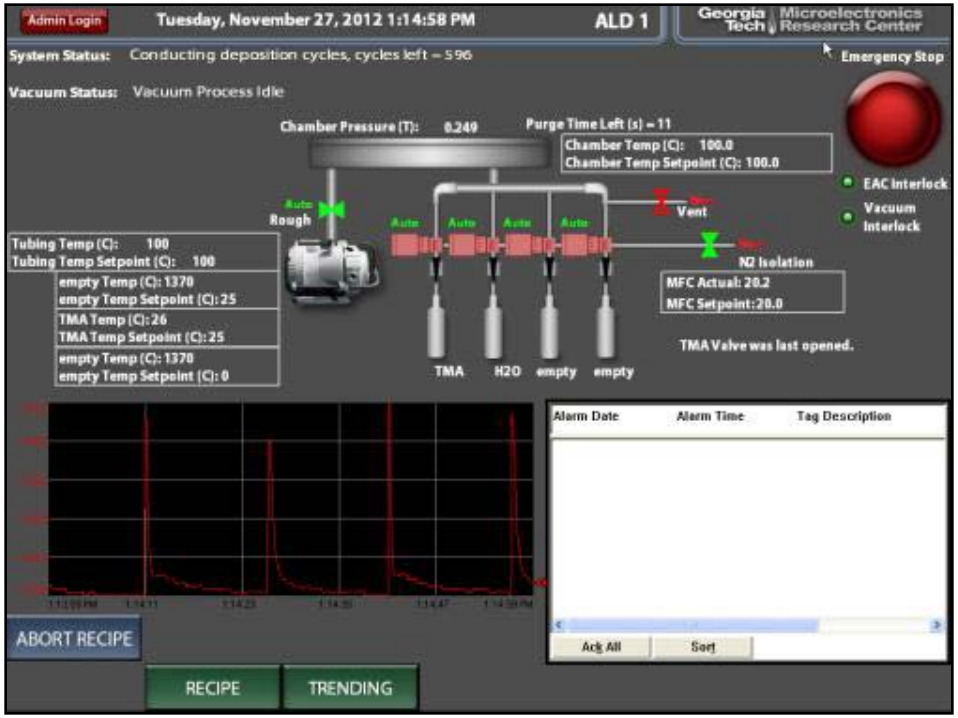


Fig 3. **Internals of ALD**

Home-built thermal ALD

- Chamber easily disassembled
- <$15k, 2 days to assemble
- Reduced cross-contamination
  - Al_2O_3 available only
- Up to 250C
  - Viton lid o-ring
  - Stainless steel chamber
- Up to 4 precursors

Fig 4. **Touchscreen Interface**



User Activity

- Aug 2010-Nov 2012:
  - 92 unique users
  - 9,000+ hrs
- Oxide/nitride chamber heavily used
- Metals chamber, not so much
- ALD2 for instructional center
  - hands-on fabrication classes
- ALD1 for Al_2O_3
  - No cross contamination (only TMA/H_2O installed)

Applications of ALD @ GT

- Gate dielectric
- Nano-porosity size reduction
- ALD on Graphene
- Environmental barrier for organic electronics
  - Polymer solar cells
  - OLEDs
- Anti-reflective coating
- Nano-generator (ZnO on CNT)

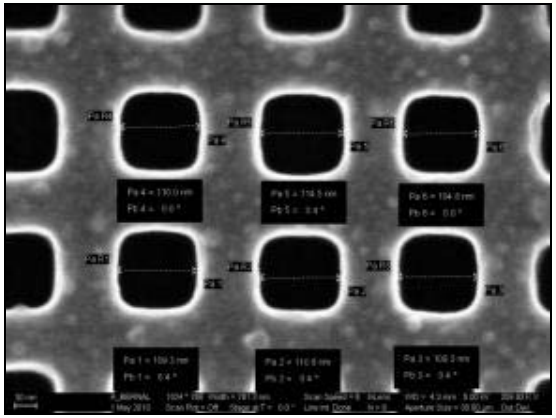


Fig 5. **Porous grid for PZT nano pillar fabrication**

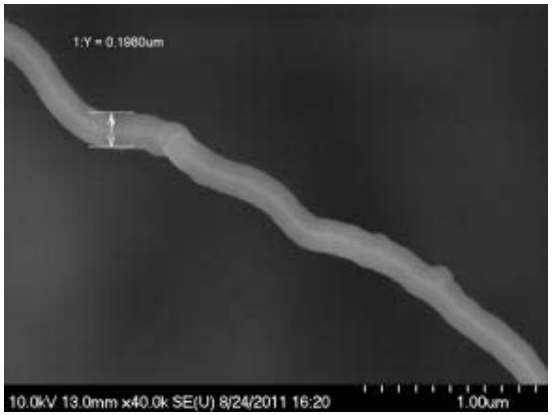


Fig 6. **20nm ZnO on individual CNT. CNT is indicated by arrows.**

Hardware Issues

- Chuck temperature cooling
  - Slow (250C to 100C)
- Cross-contamination
  - Gate dielectrics (contaminated by other nitrides and possibly ZnO)
- Manual load-lock operation
- Metal ALD precursor
  - Cost, availability, nucleation delay

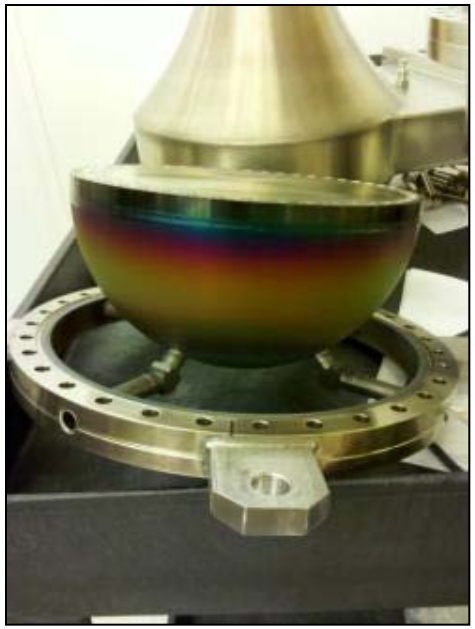


Fig 7. Heated Chuck

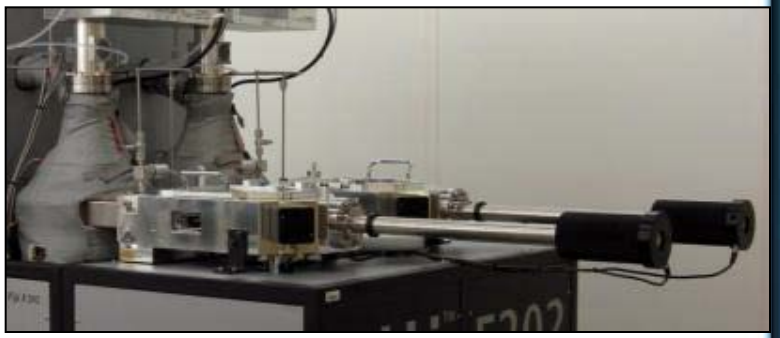


Fig 8. Manual load-lock

QUESTIONS?

http://cleanroom.ien.gatech.edu/