Atomic Layer Deposition at ASU NanoFab

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Current ALD Capability

• Cambridge Nanotech Savannah – one unit

• Available chemical precursors –
  – Trimethyl Aluminum (Al₂O₃)
  – Diethylene Zinc (ZnO₂)
  – Tetrakis (dimethlamino) Hafnium(HfO₂)

• First film (Al₂O₃) deposited on 9/27/2012
c/o J Provine & M. Rincon (Stanford)
  – Growth rate 0.88 Å/cycle (15 ms dose)

• HfO₂ deposition – (10 ms dose)
  – Growth rate 0.95 Å/cycle
Al$_2$O$_3$ Growth Rate

Dose = 15 ms

Relative Thickness (Å) vs. Number of Cycles

$y = 0.88 \times x$

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Equipment Issues

- TDMA- Hf pre-cursor needs heater jacket at 75 °C
  - Always have to enter this set point thru GUI otherwise heater doesn’t come on
- We have APS UPS and every time we login we get the following dialog box
  - “Do you want to allow the following program to make changes to this computer?”
- After launching the tool software, we frequently get the following error
  - USB ERROR/From Command: MPUSBWrite/Called from Savannah.vi
  - Power cycling the circuit breakers on the front of the tool rectifies this error?
- One run aborted during a Windows update
  - Is this common?
- Over pressure abort (> 1 Torr) when we first ran HfO₂
  - Reducing the dose from 15 ms to 10 ms fixed the problem
  - But this value is faster than the valve can operate?
- Cambridge Nanotech support
  - No response to email sent 11/19/2012 and web site access denied.....
- Equipment Usage Level
  - very low % since we’re still evaluating the tool

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Future Plans

• Film characterization – thickness is relative since based on pre-existing optical models loaded in Woollam ellipsometer
  – Refractive index (need to determine independently)
• Thin Al$_2$O$_3$ hard mask for nanolithography application
  – Preliminary RIE (Cl/Ar) sputter etch data of 20 nm/min vs. 120 nm/min for PMMA is promising.
• Looking to add TiO$_2$ capability in the near future
• Proposal has been submitted for GdO$_2$, Ta$_2$O$_5$, and WO$_3$
  – Application as dielectric stack for programmable memory cells