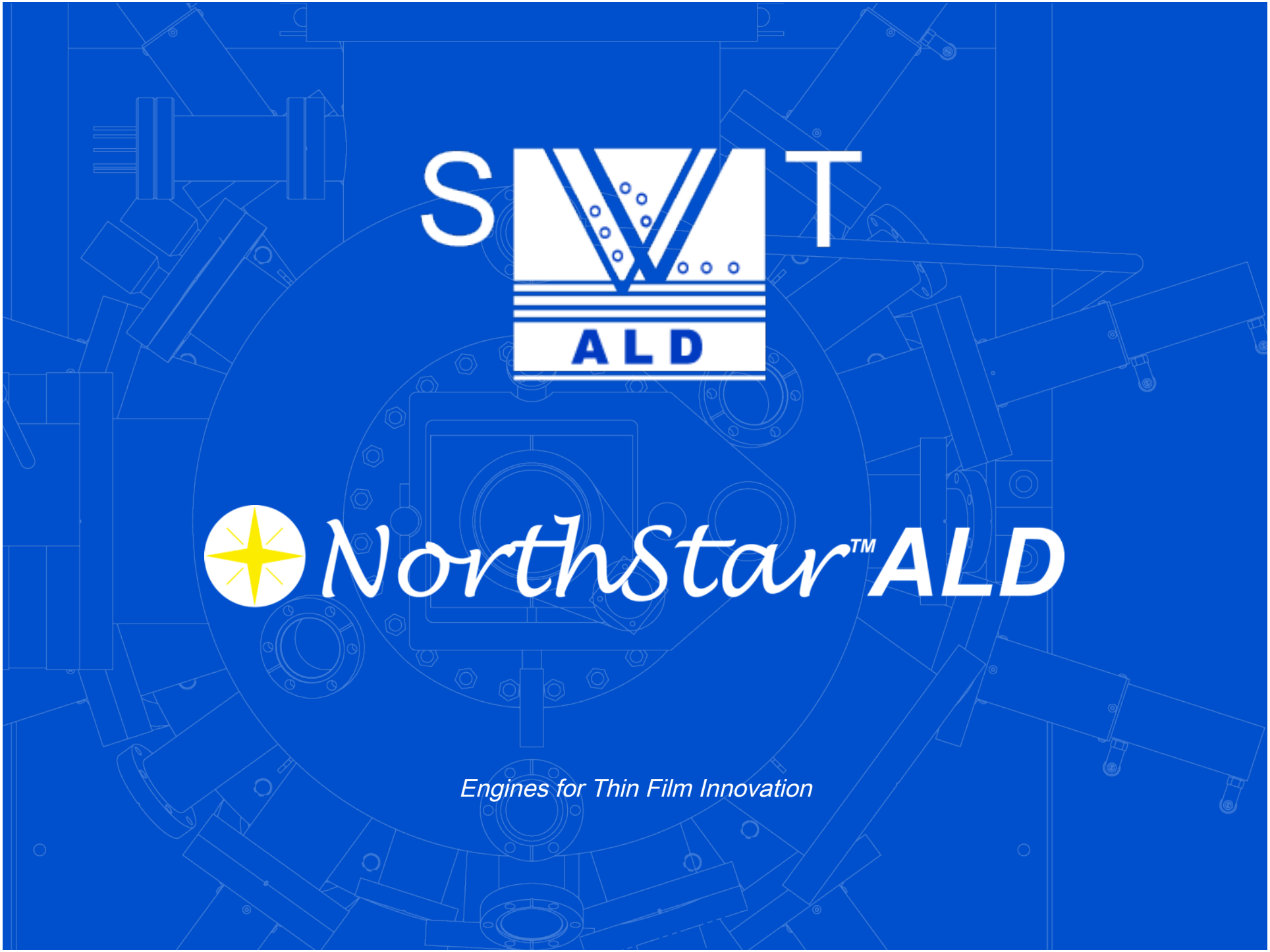

SVT
ALD
NorthStar™ ALD
Engines for Thin Film Innovation

Atomic Layer Deposition (ALD)

- ALD provides Uniform, controlled, conformal deposition of oxide, nitride, and metal thin films on a nanometer scale.
- ALD is a self limiting thin film deposition technique based on sequential gas phase chemical processes.
- Most ALD reactions use two chemicals, typically called precursors. These precursors react with a surface one-at-a-time in a sequential manner.
- By exposing the growth surface to the precursors repeatedly, a thin film is deposited.

NorthStar™ ALD

NorthStar 200mm ALD with
Load Lock Introduction

- Features
  - Hot wall deposition chamber
  - Up to 8 precursor lines, plus gas lines
  - Precursor sources located in vented cabinet
  - Rapid Substrate Heating to 500 °C
  - Small Chamber Volume and Highly efficient pumping
  - Software with Recipe flexibility for research/deposition on very high aspect ratio structures
  - Small footprint
  - Multi phase traps and filters for safe handling of exhausts

NorthStar™ ALD System

- Thermal or energy enhanced ALD
- Sample introduction is rapid and convenient with a quick hatch or the optional load lock.
- Compatible with in-situ RGA, Ellipsometry, and QCM
- RoboALD software/system automation increases process reproducibility.
- The NorthStar™ ALD system can be interfaced with other deposition and metrology tools.

NorthStar™ Atomic Layer Deposition

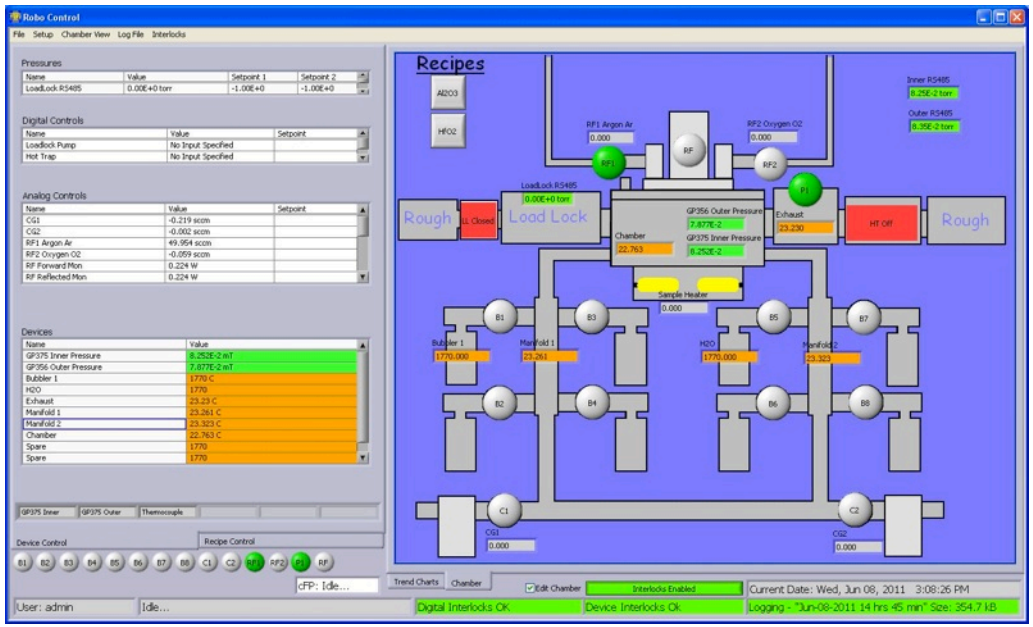
ALD 200 mm

ALD 100 mm

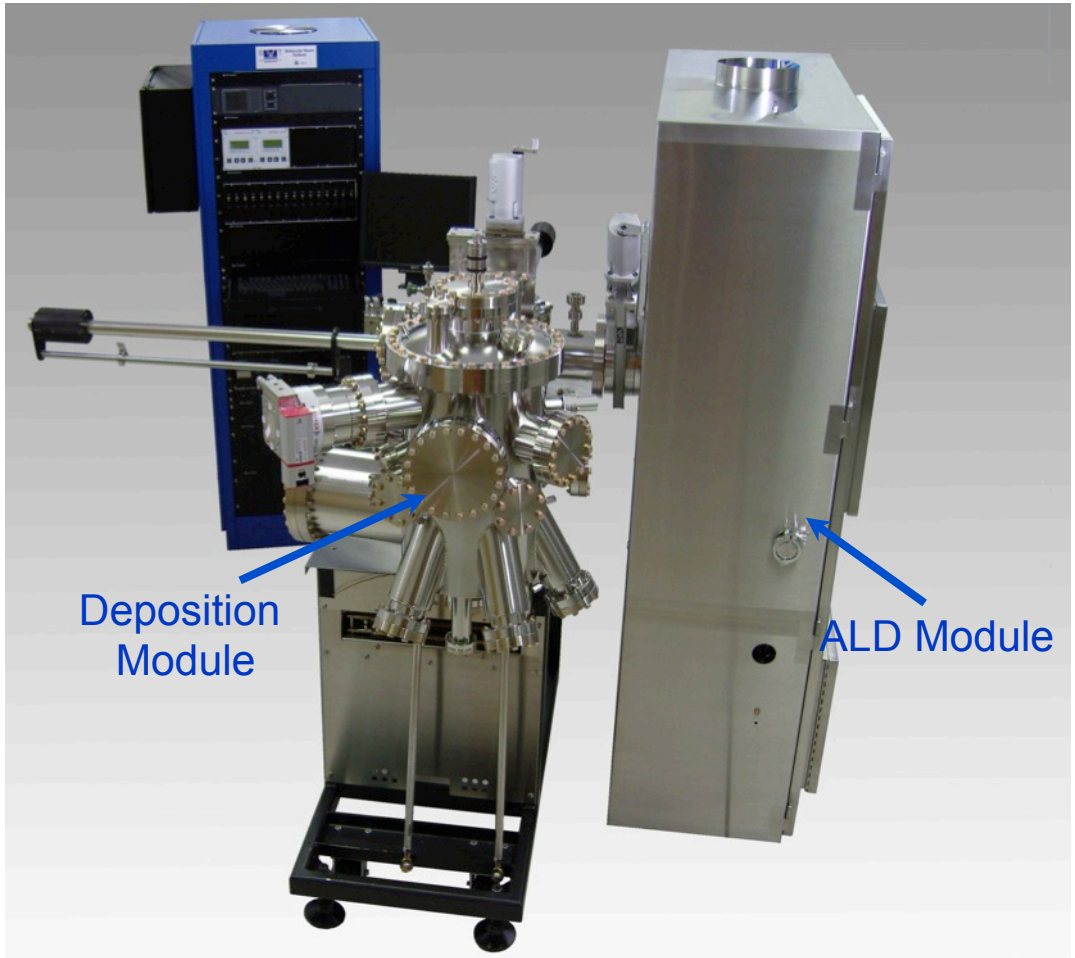
Engines for Thin Film Innovation

RoboALD™ Process Control Package

- Recipe definition with flexible parameters
- Fast ALD Valve Control
- Temperature Control
  - Substrate Heating
  - Chamber Wall
  - Precursor
  - Gas Lines
  - Exhaust Line
- Carrier Gas Control
- Data logging of parameters
- Process alarms
- Residual Gas Analyzer Monitoring
- Automated Pumpdown and Venting
- PLC Controller for real time control



Integrated ALD/UHV Deposition System



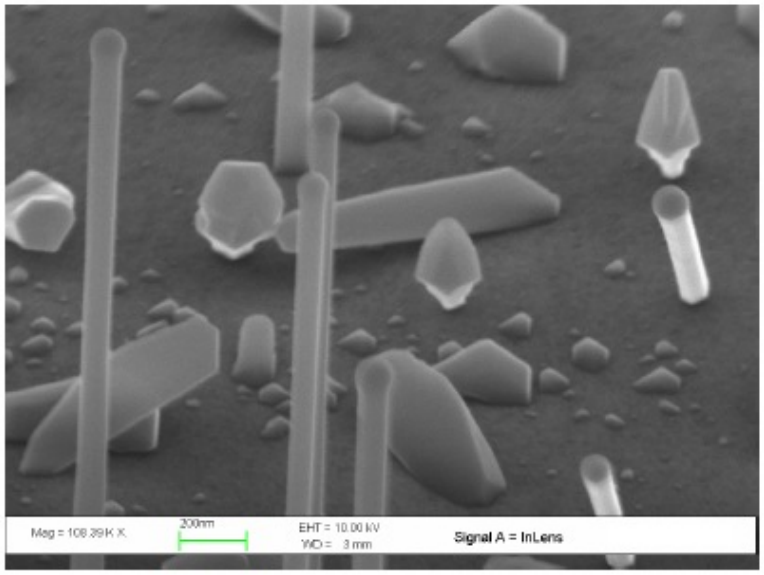
Engines for Thin Film Innovation

ALD Materials and Applications

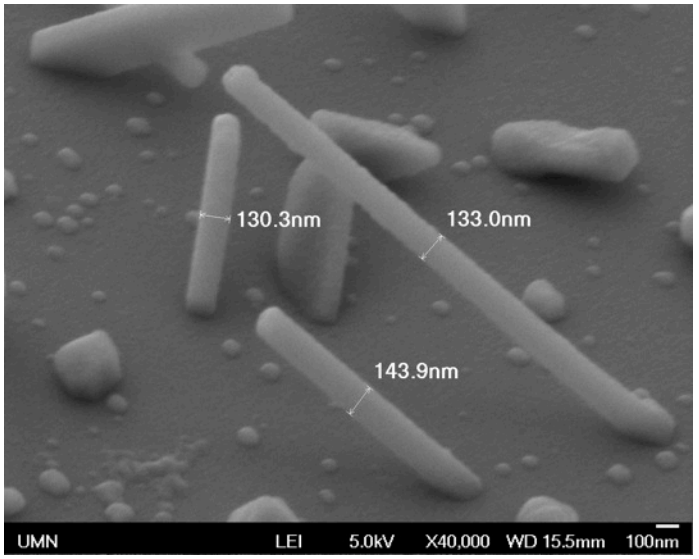
High-k Dielectrics	Al_2O_3, HfO_2, ZrO_2, PrAlO, Ta_2O_5, La_2O_3	Transistor gate oxide, DRAM capacitors, on both Si and III-Vs
ALD Metals	Ru, Pd, Ir, Pt, Rh, Co, Cu, Fe, Ni, TiN, WN, TaN	Metallic for interconnects, diffusion barriers, conductive gate electrodes
Nanostructures & Nanophotonic Crystals	ZnO, ZnS:Mn,TiO_2, Ta_3N_5	Coatings inside porous alumina, inverted opals, coating nanoparticles, nanowires, nanolaminates
Environmental barrier/ OLED passivation	Al_2O_3, SiO_2	Food packaging polymers, biocompatible polymers
Catalytic Membranes/ Gas Separation	Pt, Ir, Co, TiO_2, V_2O_5, SiO_2	
Biocompatible Coatings	TiN, ZrN, TiAlN	
Optical Coatings	Al_2O_3, TiO_2, ZnO, SnO_2, ZnS, Ta_2O_5	Anti-refection, optical filter, UV blocking, solar cells, fuel cells
Sensors	SnO_2, Ta_2O_5	Gas sensors, pH sensors

GaAs Nanowires with Al_2O_3 Coating by ALD at SVT Associates

Al_2O_3 coating by ALD shows excellent conformity and uniformity



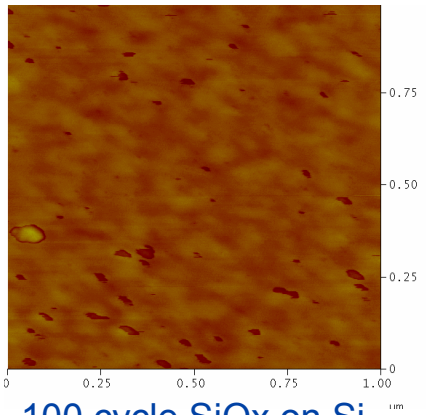
Average diameter of bare GaAs nanowires: 85nm



Al_2O_3 coating thickness: ~20nm

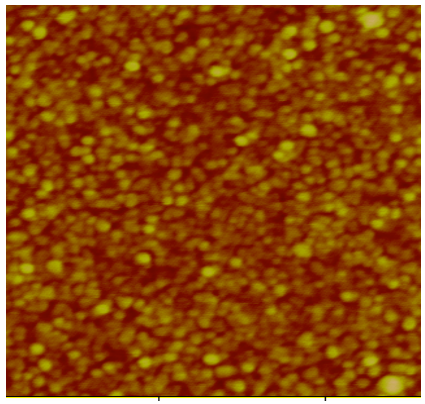
In/Ex–Situ Characterization of ALD Oxide Films

Room Temperature



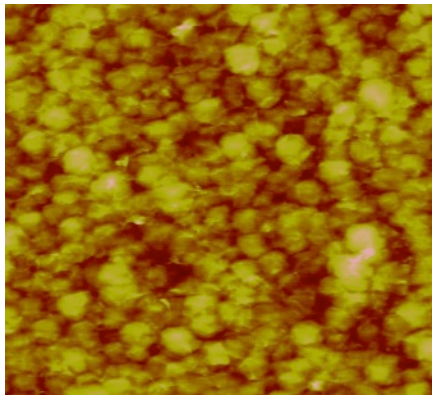
100 cycle SiOx on Si

150 °C



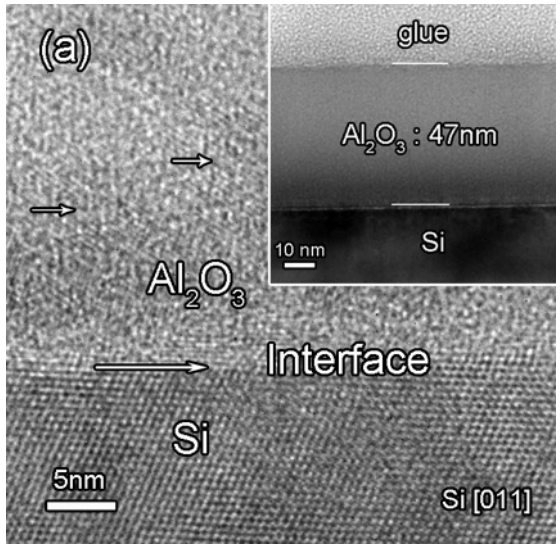
~50nm Al_2O_3 on Si

250 °C



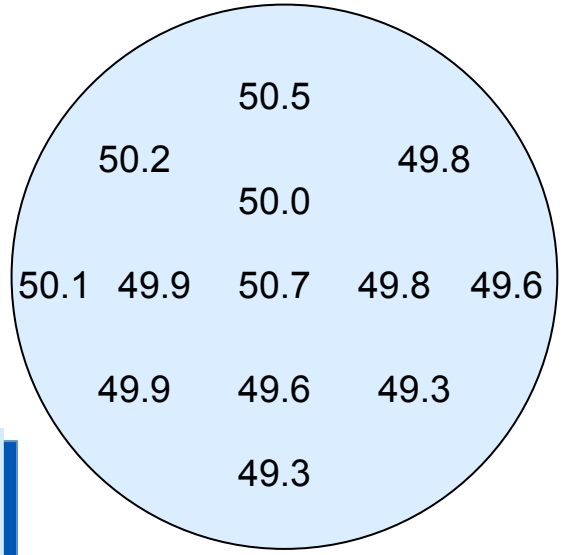
~50nm ZnO on Si

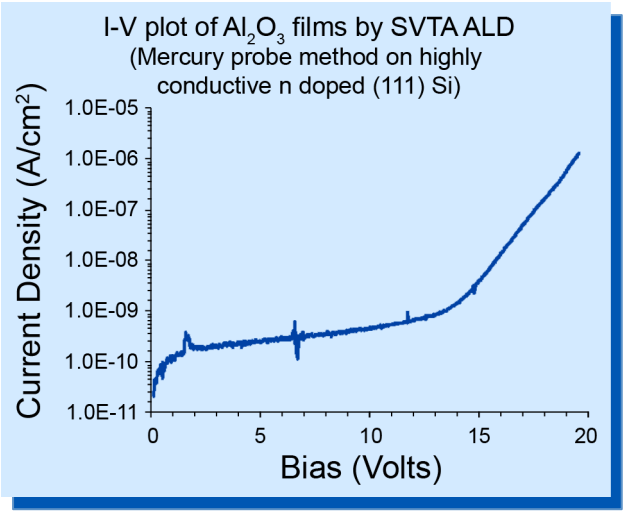
Cross-Sectional HRTEM shows sharp interface between Al_2O_3 and Si which is free of SiOx.

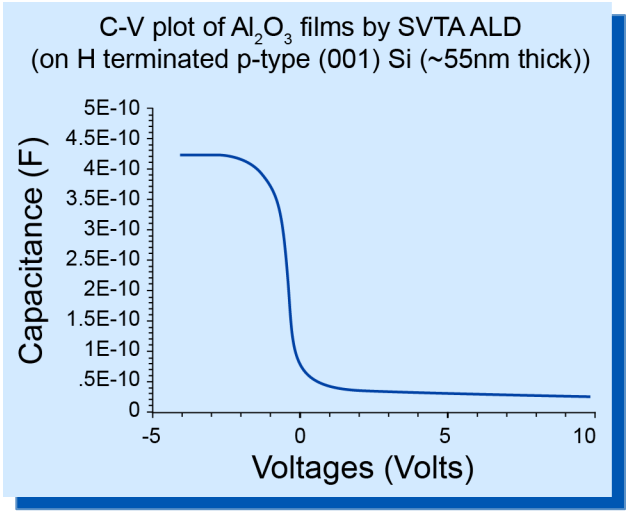


Electrical Characterization of Al_2O_3

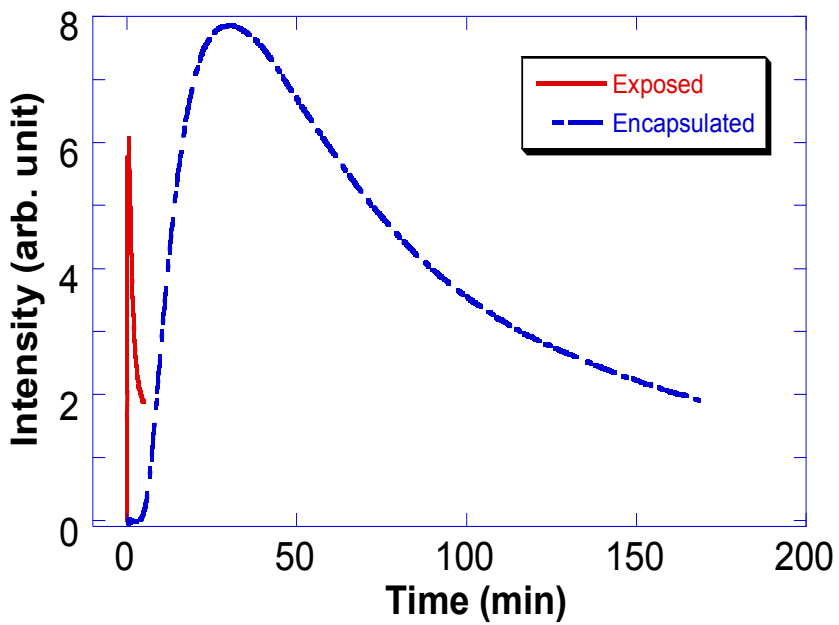
- Thickness Uniformity: < ±1% for ALD Al_2O_3 film on up to 4" Si wafer;
- Leakage Current <1 nA/cm^2 at 2 MV/cm
- Breakdown Field: 8-10 MV/cm;
- Dielectric constant of as-grown film ~8







ALD Al_2O_3 Film as a Barrier Layer

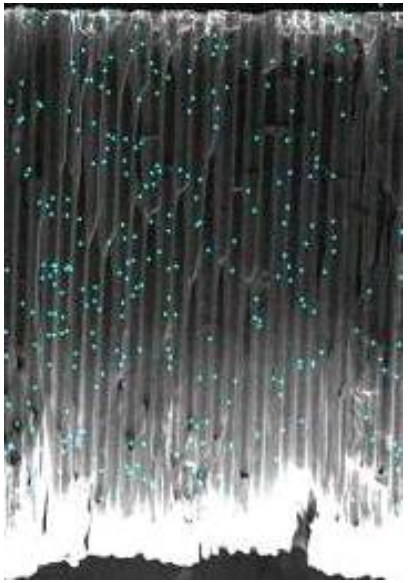


Luminescence Decay Curves in Air*

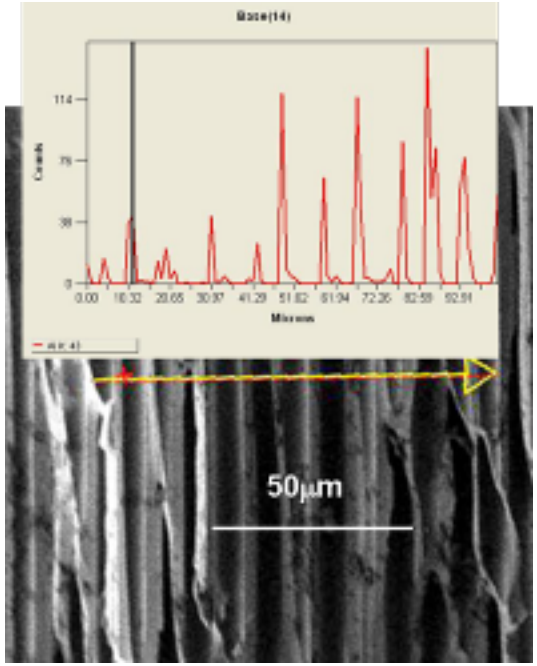
An illuminated OLED

- SVT Associates demonstrated the half-life of encapsulated short-lived OLED increases from ~1 minute to over an hour indicating the great potential of ALD for forming highly effective barrier layers.
- Corrosion of backside cathode metal can be inhibited by the barrier layer.

Microchannel Plates (MCP)



A cross sectional SEM image and Al elemental mapping (blue dots) of an Al_2O_3 coated glass MCP. (Aspect ratio: 60)



An enlarged cross sectional SEM image and an Al elemental line scan across many pore channels.

The NorthStar™ ALD System

- Flexible process parameters for Research – Development environment
- LabVIEW® Software
- Thermal Process and Plasma Process
- Material demonstrations available
- Lab scientists provide process support
- Interface to other systems (esp. UHV)
- Worldwide service support