ALD at University of Minnesota

Cambridge Nanotech Savannah installed April 2007

All 5 lines of precursors are used:
Al2O3 Trimethylaluminum TMA & H2O
HfO2 Tetakis(dimethylamido)hafnium(IV) & H2O
SiO2 Tris(tert-butoxy)silanol BST & TMA
TiO2 Titanium(IV) isopropoxide TTIP & H2O
ZnO Diethylzinc DEZ & H2O

Some groups are doing AZO films (TMA doping of ZnO film)

Few users do laminate layers.
Basic ALD items:

Most used film is Al2O3 and second is SiO2 film.

Most users not allowed to write their own recipes, staff has control of that, reduces clutter and safety concerns.

Several outside companies and some outside universities use the ALD system. Temperature range 50 C to 300 C.

No Bio material is allowed into the system.
Using ver 25.3 software
ALD at University of Minnesota

Process examples:
DRIE masking using Al2O3 works great, process sequence:
ALD deposit – Photo – Dry etch pattern using BCl3 – DRIE step.
ALD at University of Minnesota

Process examples:

Solar panel coating Brookings, SD

Thin film deposits – 20 to 40 Ang and some are working to do 10 Ang

Micro bolometers define Si pattern and also use ALD film as support
Only a 200 -300 Ang film for Si etch masking and support structure too.

Bio compatibility layers done by several groups.

Nano particle coating

Normal insulting layers
F vs. H Passivation on MOSCAPs…Testing

Current Fabrication Process:
Testing............200 kHz, 50 kHz, 10 kHz, 5 kHz, 1 kHz

4 Samples – **Bare** (No surface treatment), **H-passivated** (BOE dip before HfO2 deposition), **F-passivated** (SF6 exposure before HfO2) & **HF-passivated** (BOE dip followed by SF6 exposure before HfO2)

**MOSCAP Process Flow…..**
1. Backside Metallization (200 nm Al)
2. Backside Contact Anneal (400C)
3. PR Spin & Bake Backside
4. HF-Dip or SF6 Plasma Exposure
5. Dry with N2
6. Oxidize in Air – 1 week
7. HfO2 Deposition (ALD, 30 nm)
8. Dielectric Anneal (400C H2/N2)
9. Top Contact Metallization (150 nm Al)
10. Test
Hardware changes

Replacement lids were made, all out of Al except one out of stainless steal.

Have installed O2 gas and H2O2 on the H2O line for short term to do testing.
Extra space in top lid by having it slightly taller, 7 mm.

With the normal 5 mm total height of sample is 12 mm.
ALD at University of Minnesota

Hardware changes

Close up view of the tall lid. Only need to replace top lid.
ALD at University of Minnesota

Hardware changes

Ring
45mm
tall

Just place top lid on top.
Hardware changes

D spacers in tall ring

D spacers are solid Al
ALD at University of Minnesota

Hardware changes

Ozone generator

monitor

This is still being worked and being set up
ALD at University of Minnesota

Past troubles - future issues.

Stop valve dirty (too cold) SiO2 film blamed. Side fitting strips out.

The lid leaking warped lid – made new lids.

PC went bad program would stop randomly, new PC box fixed it.

Pressure giving random spikes – bad connection to pressure sensor.

Future items to be worked on is ozone and more precursors.

Parts and support for the system is unknown.
ALD at University of Minnesota

My interests and questions

- Equipment modifications?, doing non-ALD films, How do you run system?
  ( vent at end of run/ include temperature control with film deposition )
- Users write recipes? Operating Temps, parts cleaning, oil changes?

A better Stop valve design – other people have issues with it? Is it just our temp and films?
What are some of the common flow values for N2? Any thing else besides 20 sccm?

Who makes good ALD systems and what are the trade offs?

We might be looking for another ALD system maybe a PE ALD who?