ALD at University of Minnesota

Cambridge Nanotech Savannah installed April 2007

All 5 lines of precursors are used:
Al_2O_3 Trimethylaluminum **TMA** & H_2O
HfO_2 Tetakis(dimethylamido)hafnium(IV) & H_2O
SiO_2 Tris(tert-butoxy)silanol **BST** & TMA
TiO_2 Titanium(IV) ipropoxide **TTIP** & H_2O
ZnO Diethylzinc **DEZ** & H_2O

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

Few users do laminate layers.

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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 allow into the system.
Using ver 25.3 software

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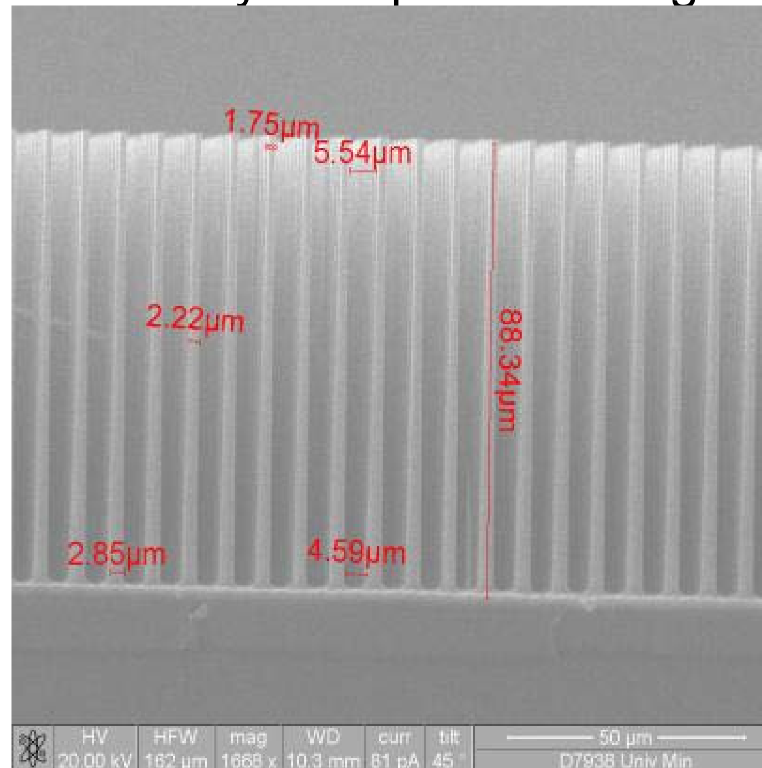
Process examples:

DRIE masking using Al2O3 works great, process sequence:
ALD deposit – Photo – Dry etch pattern using BCl3 – DRIE step.



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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

4" Wafer

Al Contact – 200 nm
HfO2 Layer
n-Si Substrate
Backside – 200 nm Al

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

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)

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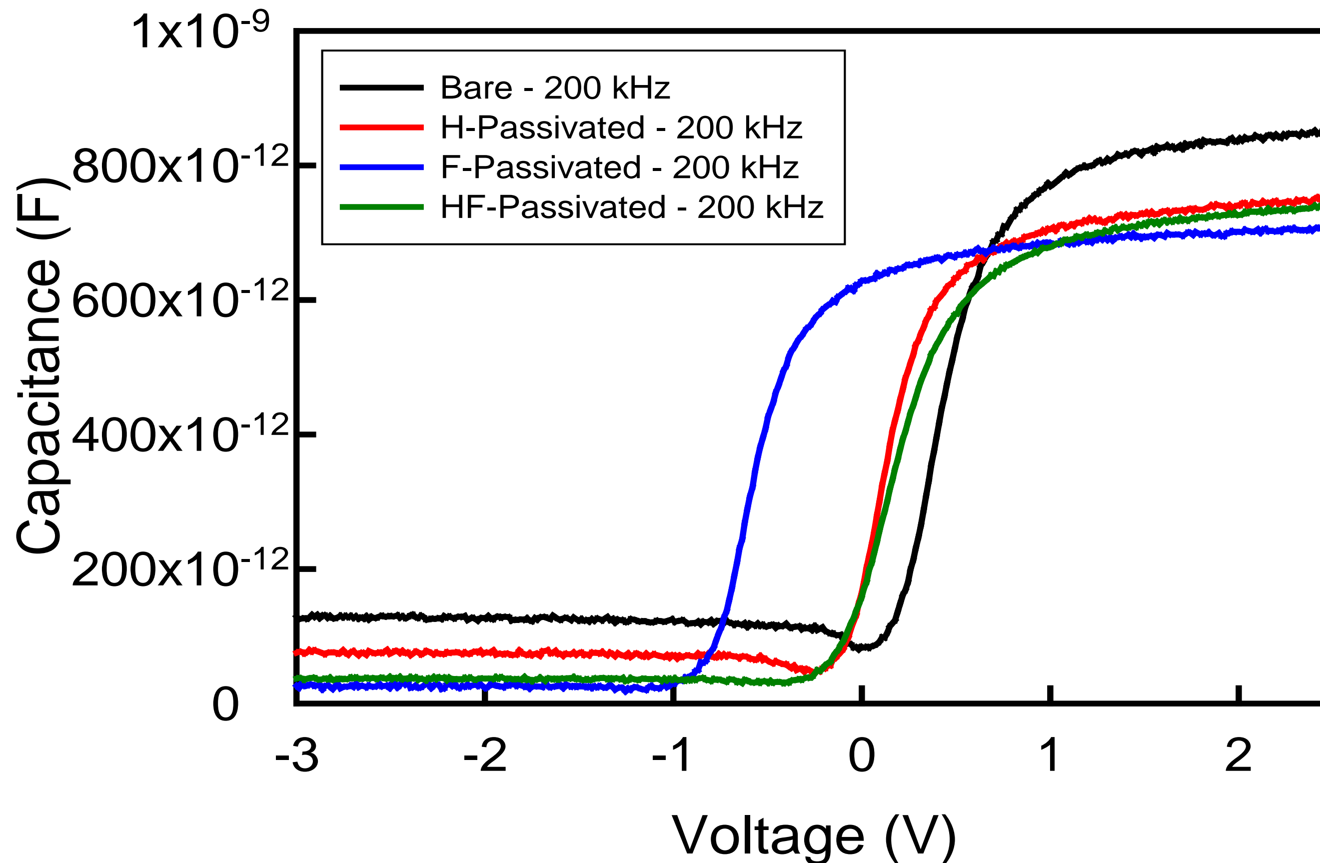
Shift in V_{FB}



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Hardware changes

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

Have installed O_2 gas and H_2O_2 on the H_2O line for short term to do testing.

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Hardware changes

Extra space in top lid by having it slightly taller, 7 mm.

With the normal 5 mm total height of sample is 12 mm.

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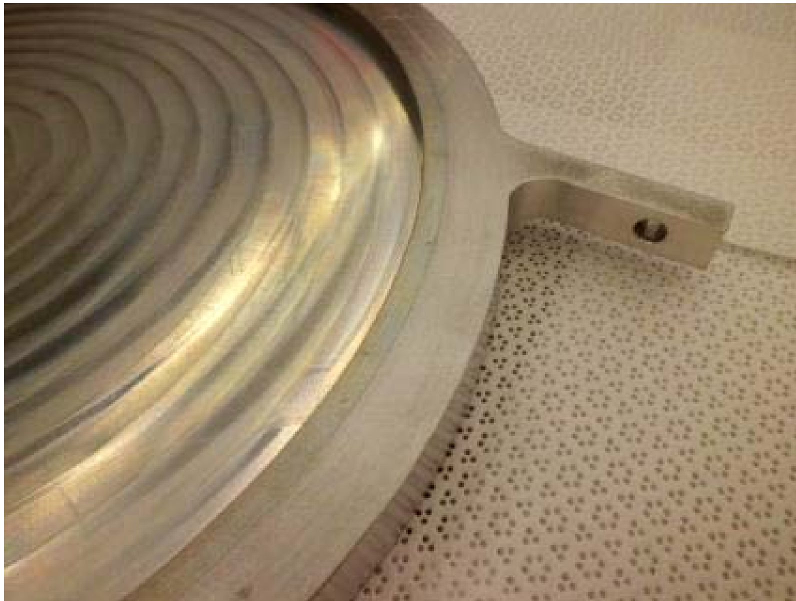
Hardware changes

Close up view of the tall lid. Only need to replace top lid.



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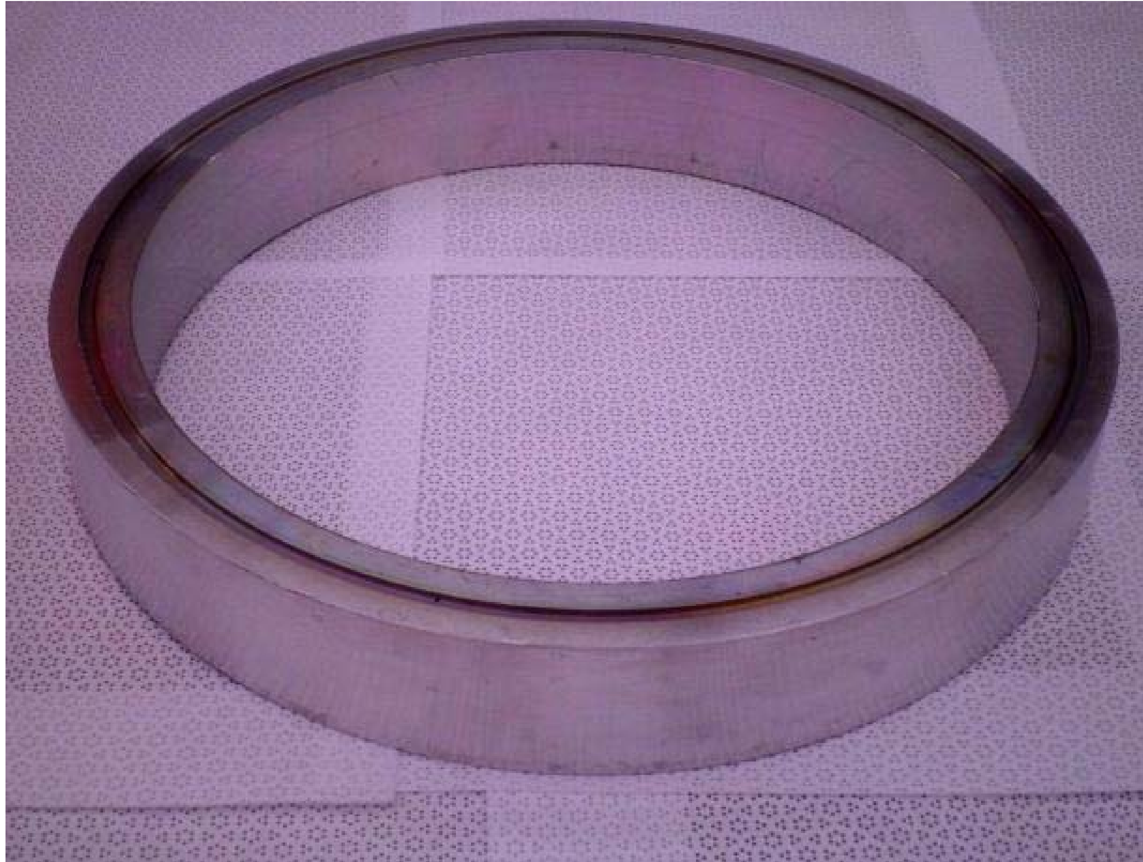
Hardware changes

Ring
45mm
tall

Just
place
top lid
on top.



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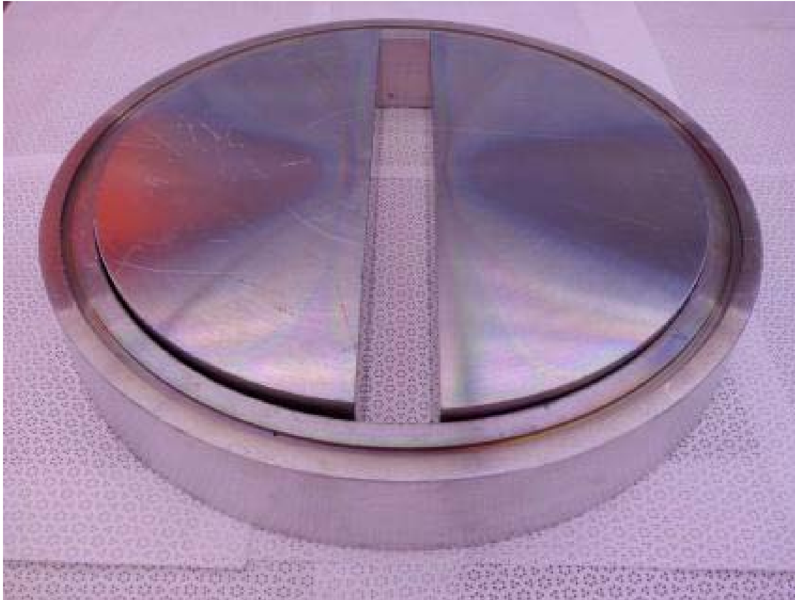
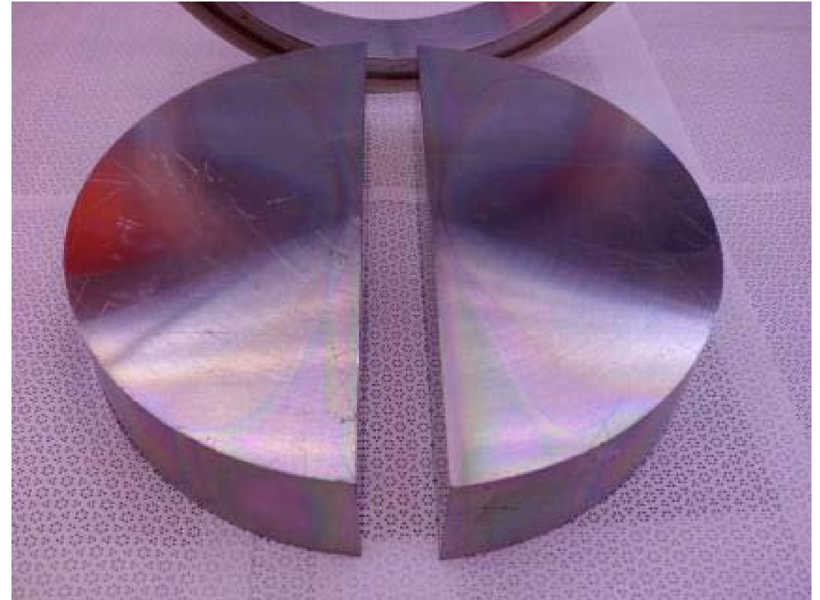
Hardware changes

D spacers in tall ring



D spacers are solid Al



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Hardware changes

Ozone generator

monitor

This is still being worked and being set up

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Past troubles - future issues.

Stop valve dirty (too cold) SiO_2 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.

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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?