



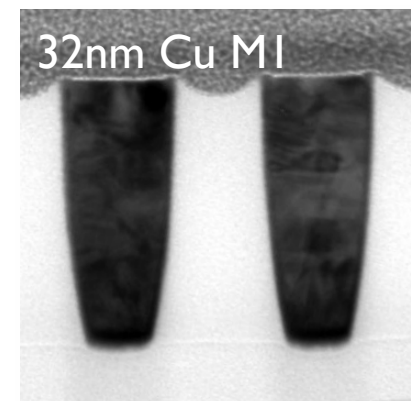
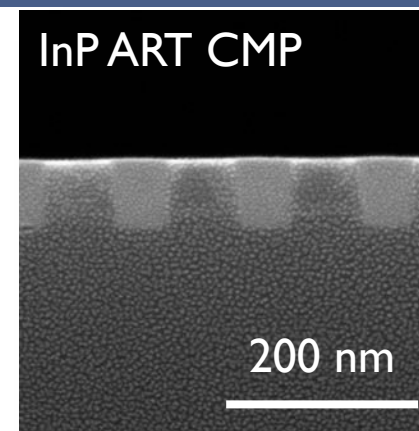
**CMP PRESENT AND FUTURE TECHNICAL AND
ECONOMIC CHALLENGES
AVS CMPUG SEMICON WEST 2014 MEETING**

Albany Nano Tech Advanced Planarization Center

SUNY CNSE: Frank Tolic, Tricia Burroughs, Brett Baker-O'Neal, Chris Borst
SEMATECH: Richard Hill, Chris Hobbs, Bill Ross, Edward Barth,
Satyavolu Papa Rao

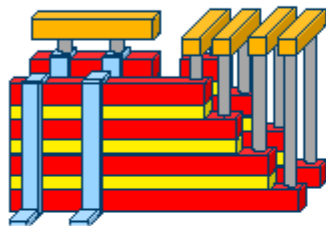


- **Problem Statement:** CMP R&D constrained by cost/access to leading edge materials, tools, metrology and test vehicles.
- **Objective:** Establish a Planarization Center to enable supply chain development/benchmarking and accelerate process maturity for end users
- **Approach:**
 - 1) Leverage the SEMATECH network to design an industry-standard mask-set
 - 2) Establish a partnership ecosystem using CNSE's leading edge fabrication, engineering, metrology/defect toolsets, and university network
 - 3) Fully engage the CMP community (consumable, tool, metrology) and end-user stakeholders (IDM, foundry, fabless, EDA)

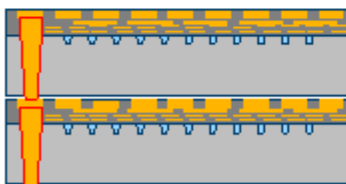




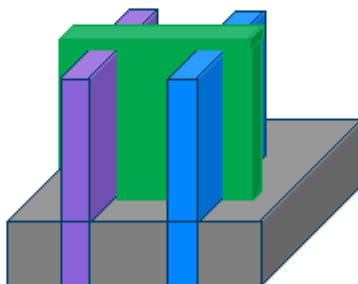
The Drivers of Change and Challenges for Manufacturing Technology



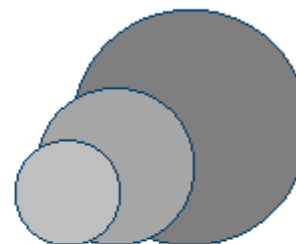
New Memory



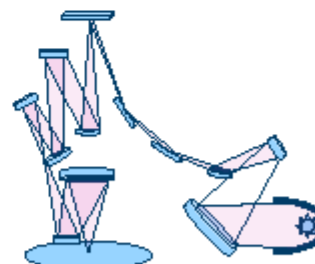
3D Packaging



Gate Architecture
And new channel materials



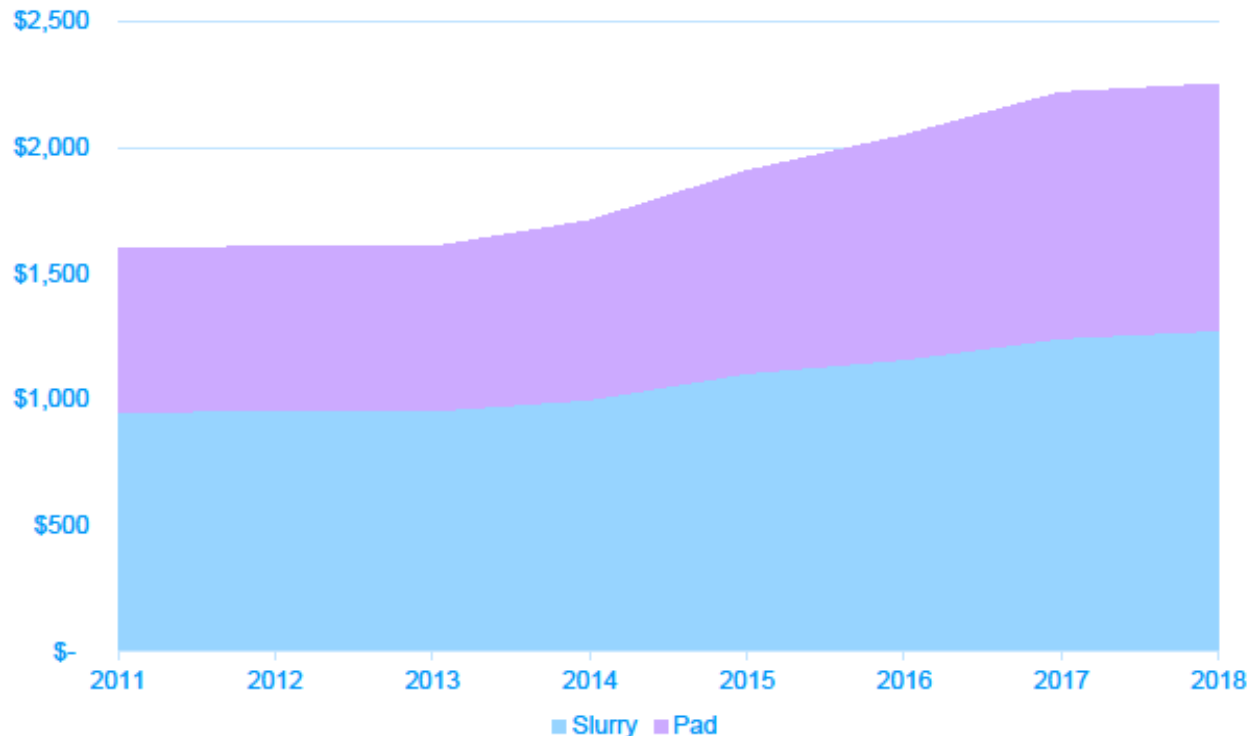
450mm



EUV



Slurry and Pad Forecast (\$M)



CMP Markets & Technologies 2013
External Disclosure Not Permitted

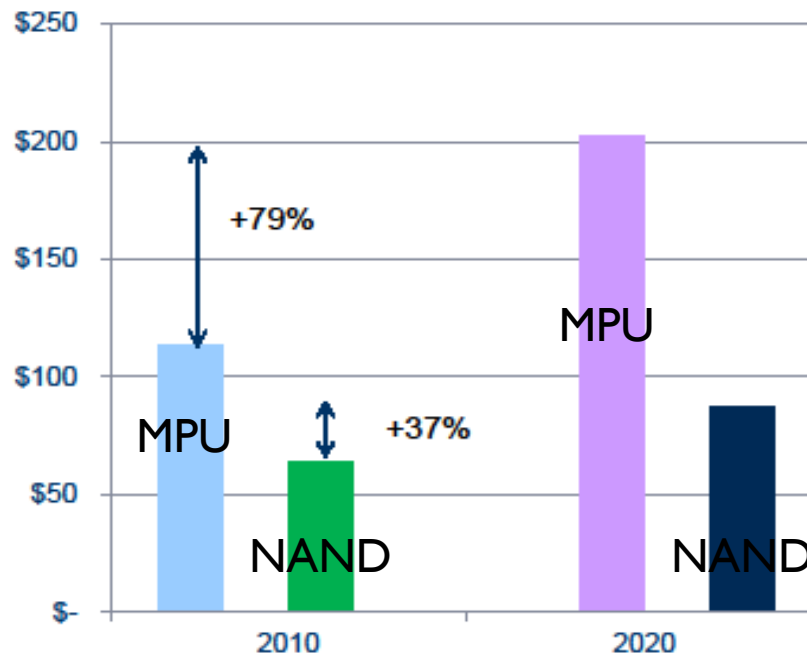
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Emerging Technology & New Materials driving growth. How to manage costs?

WWW.SUNYCNSE.COM

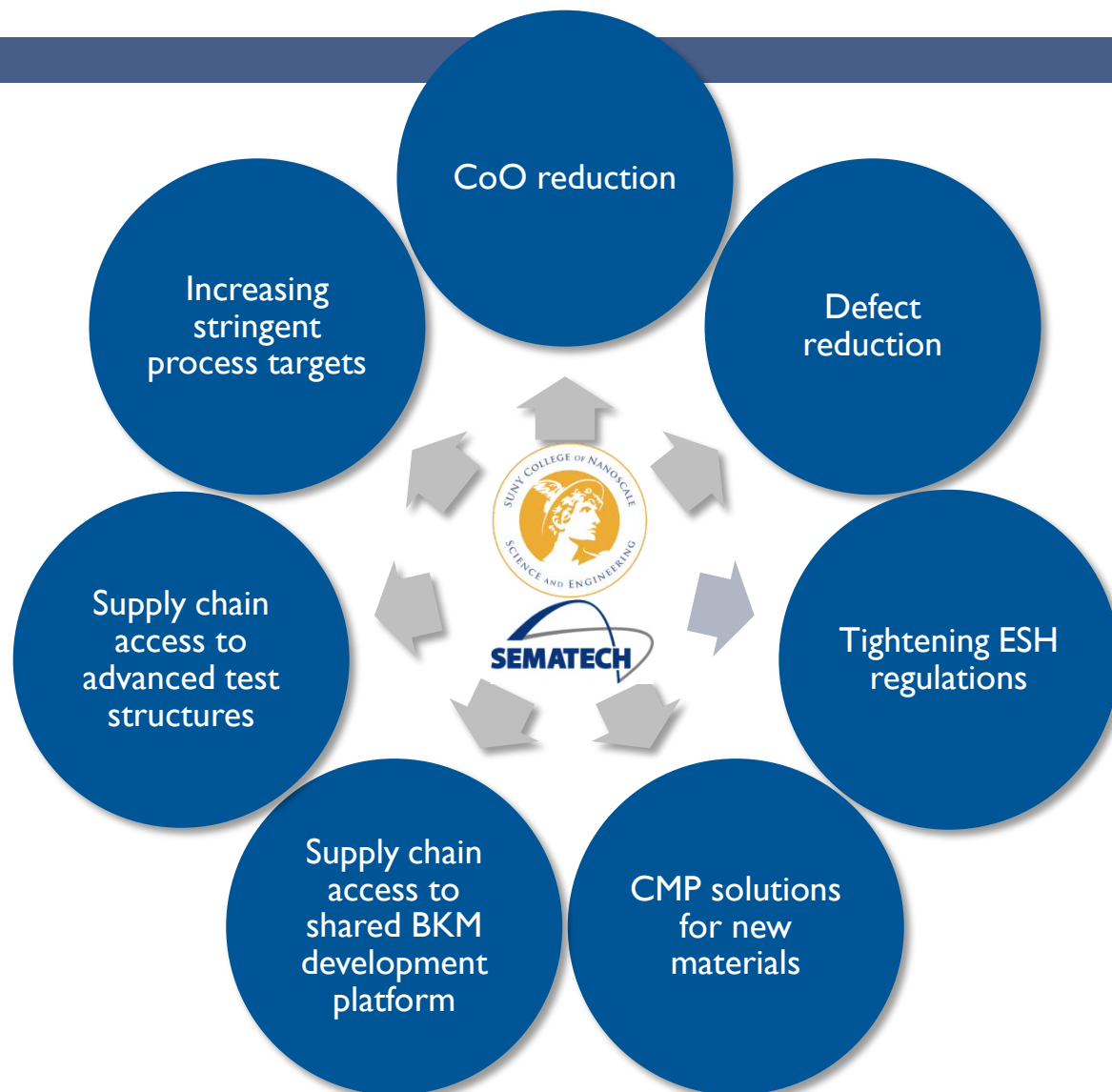


Impact of 450mm - Cost of CMP (\$/Wafer Basis)



Cost of CMP includes Depreciation, equipment maintenance, direct & indirect labor, facilities, test & Monitor wafers, consumables and yield loss

Must start addressing these cost challenges now!



Planarization center: Accelerate solutions to address industry challenges

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Planarization Center Beneficiaries

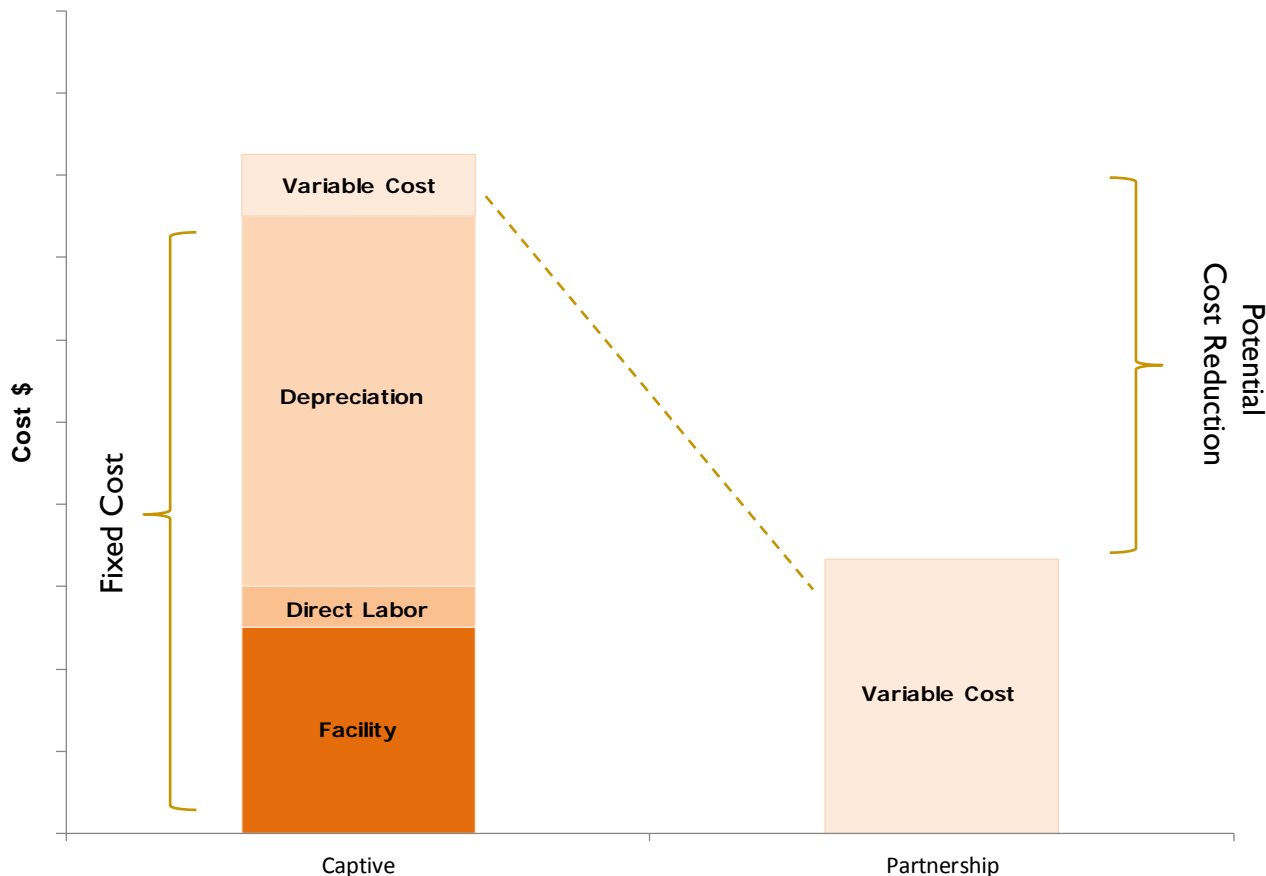


**Integrated Planarization
Center**

**Offers benefits to
entire CMP community**



Planarization Center Cost Advantages



Using a shared research model provides Significant Cost Savings!



Acknowledgements:

Linux-Consulting:	Mike Corbet
StartUp NY:	Merideth Bahr Andreucci
G450C:	Dr. Christopher Borst

CNSE Team

SEMATECH Team

Planarization Test Masks: Past and Present

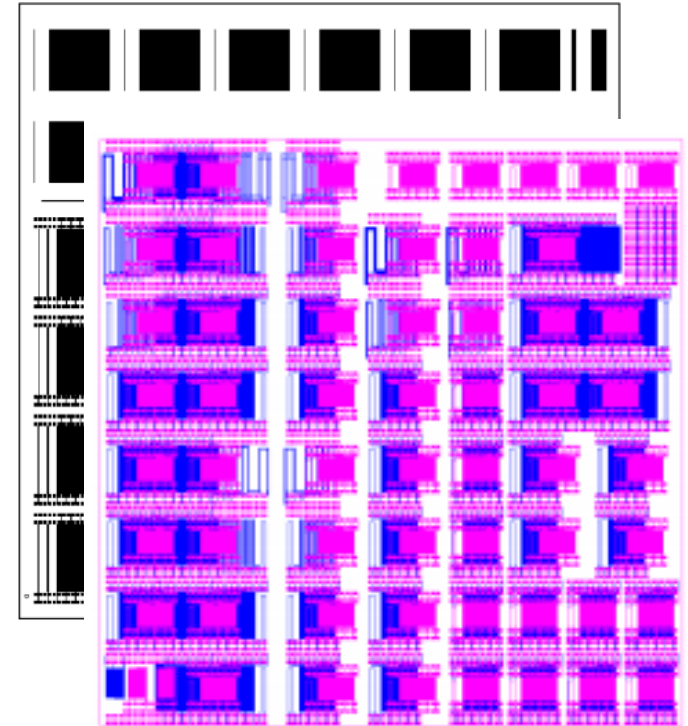
SEMATECH/MIT mask-set became the *de facto* CMP workhorse for the industry in the late 90's

Features

- Comprehensive geometries (100 nm)
- Multi-layer topography

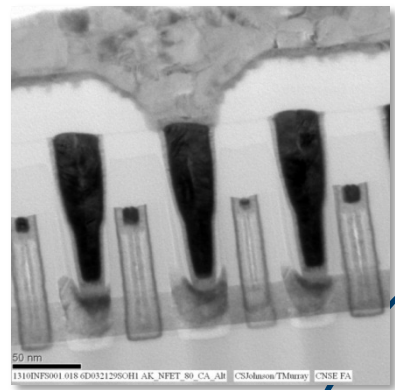
Value

- Process characterization
- Consumable benchmarking
- Standardization of results



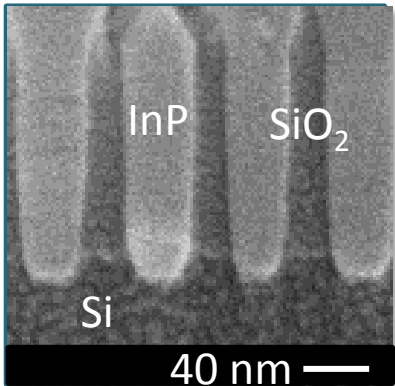
20 years of scaling & new materials demand an updated CMP standard mask-set to meet sub-14nm challenges

Planarization Center Infrastructure



14 nm Test Structures

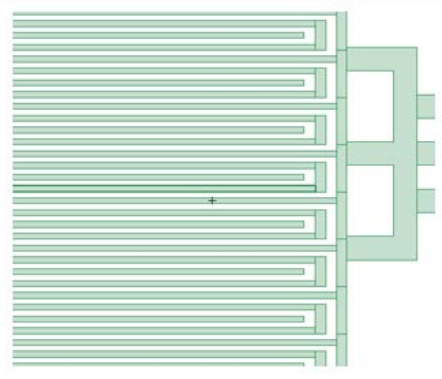
Multi vendor CMP platforms



Leading edge materials III-V, Co....

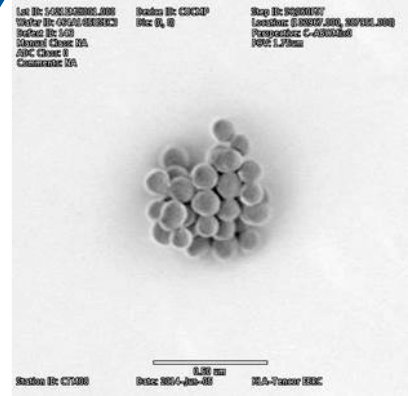


Industry Standard mask-set



Industry standard toolsets

State of the art defect metrology

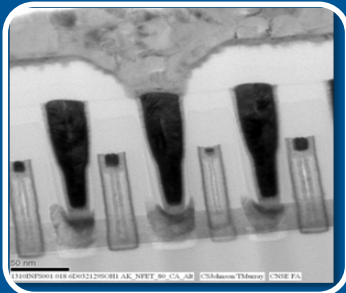


Planarization Center Focus / Phases



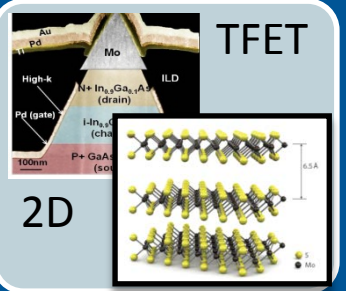
Today: CMP Process Infrastructure

- 22 nm test structure, PLY and metrology services
- 300 mm multi-platform demo services
- III-V wafer services
- COO evaluation



2015: Industry-standard test structures

- 14 nm **industry standard** test structure, PLY and advanced metrology services
- Standardized benchmarking
- 300 mm III-V demo services



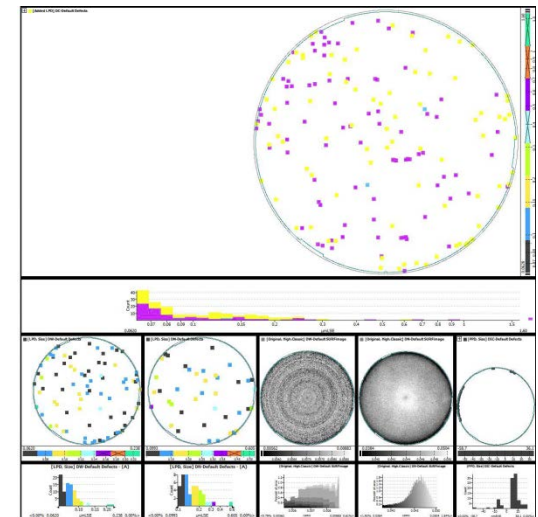
2016: Consumable Analytics & COO

- Slurry, pad, disk, filter performance analytics & COO
- Accelerated consumable lifetime evaluations
- Adaptive/tunable consumable development
- Extension to 450 mm, EUV, “Beyond-5nm” technologies



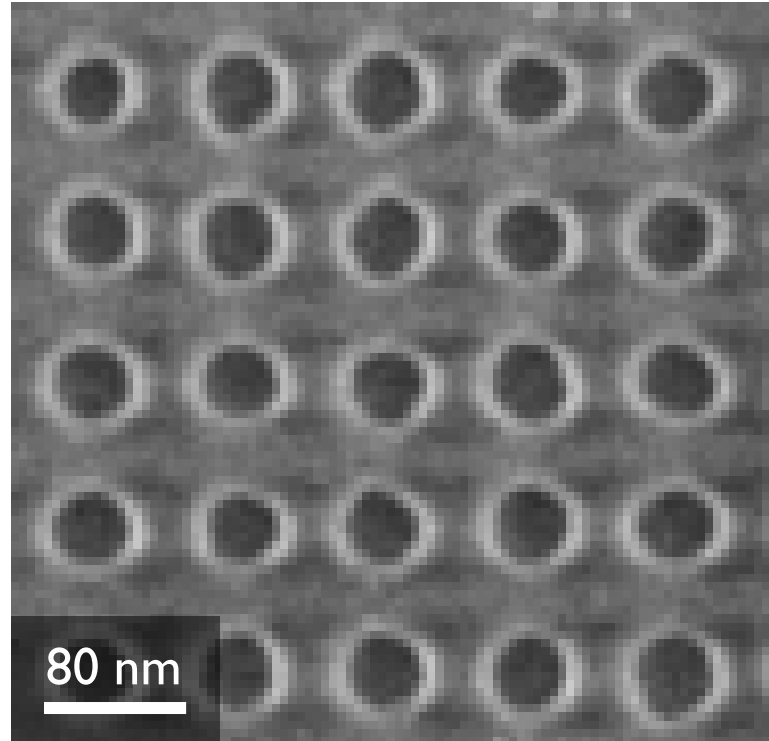
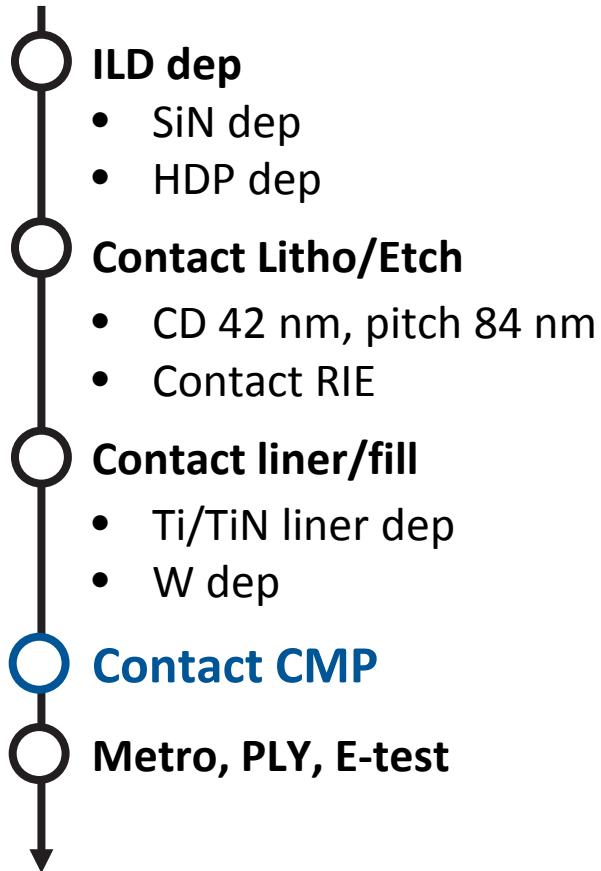
Planarization Center Unique Capabilities

- 14 nm industry standard mask-sets
- Maintained baseline w/ quantified in-line metrology targets and e-test
- Proven consortium model to drive consensus and increase ROI for CMP supply chain.
- Synergy between centers of excellence: EUV, III-V, 3DI, G450C, CNSE derivatives



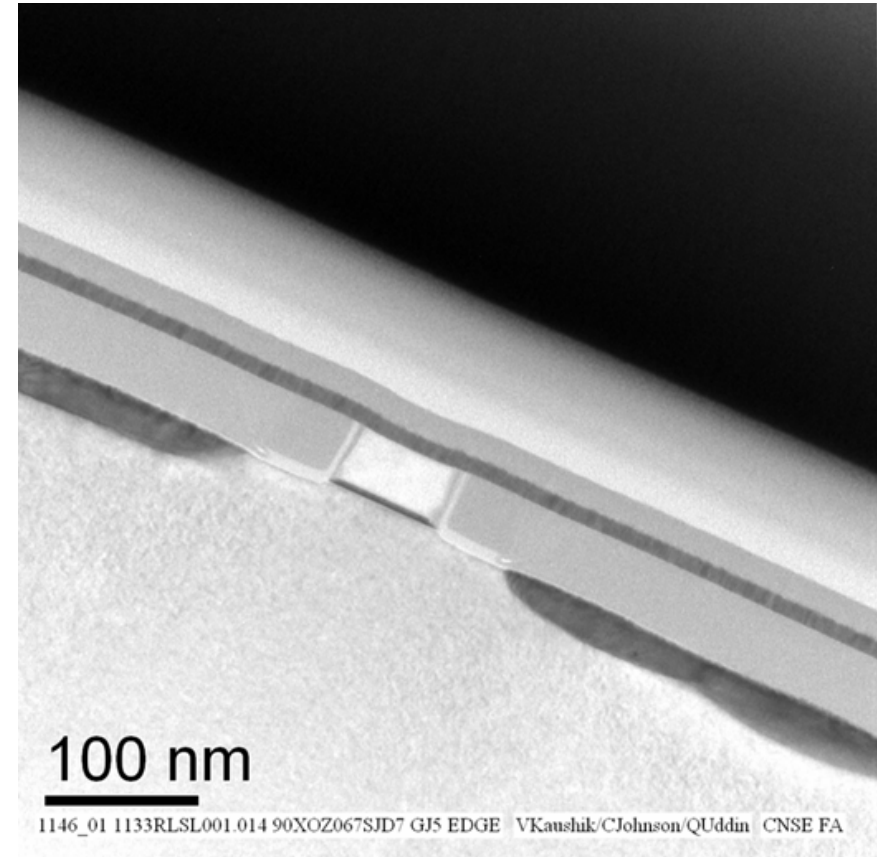
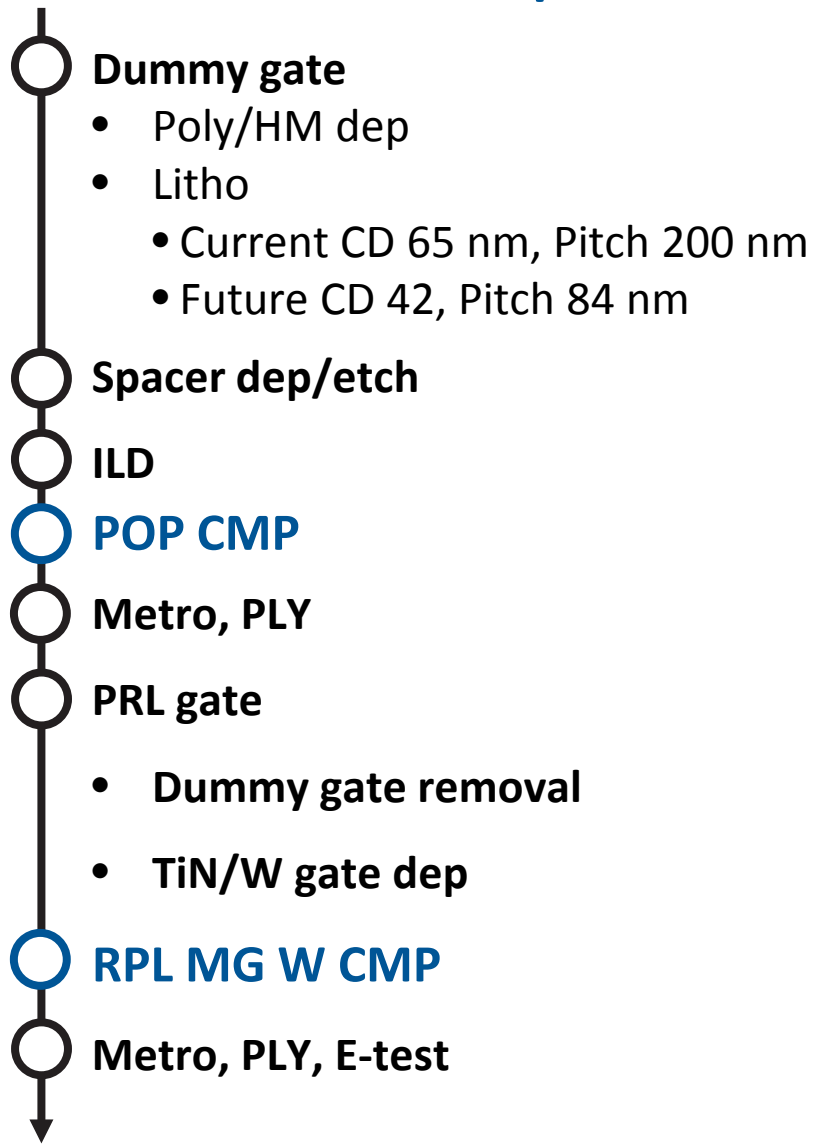
SP3 Output

W contact



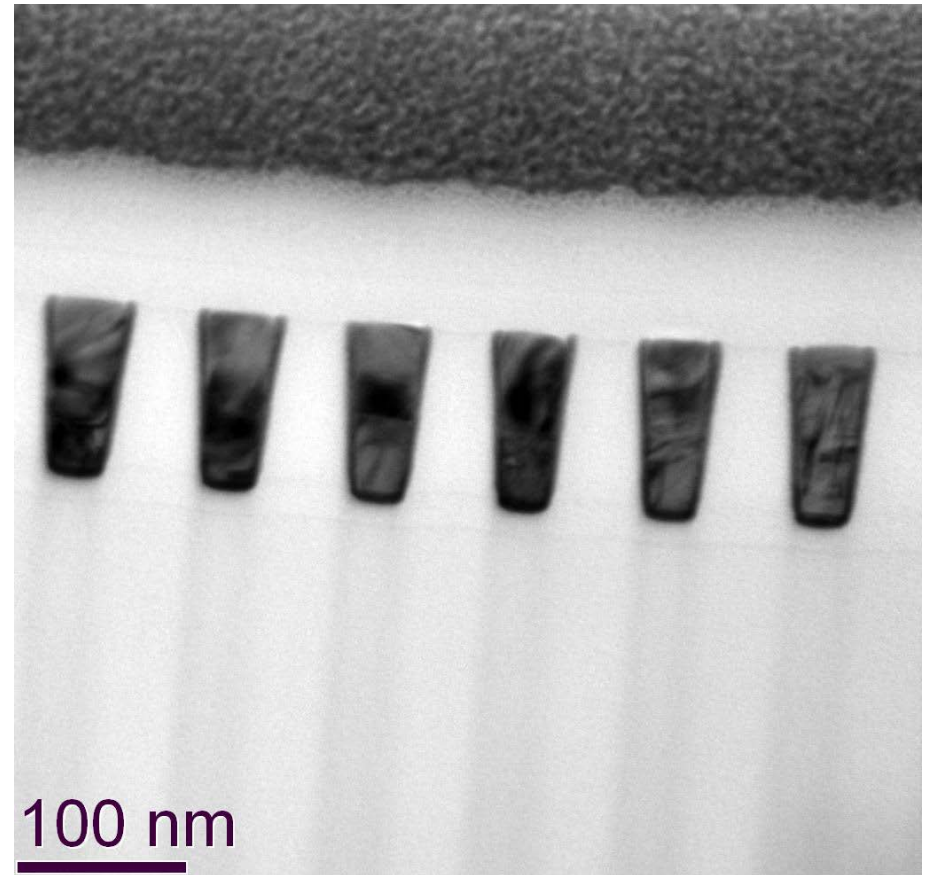
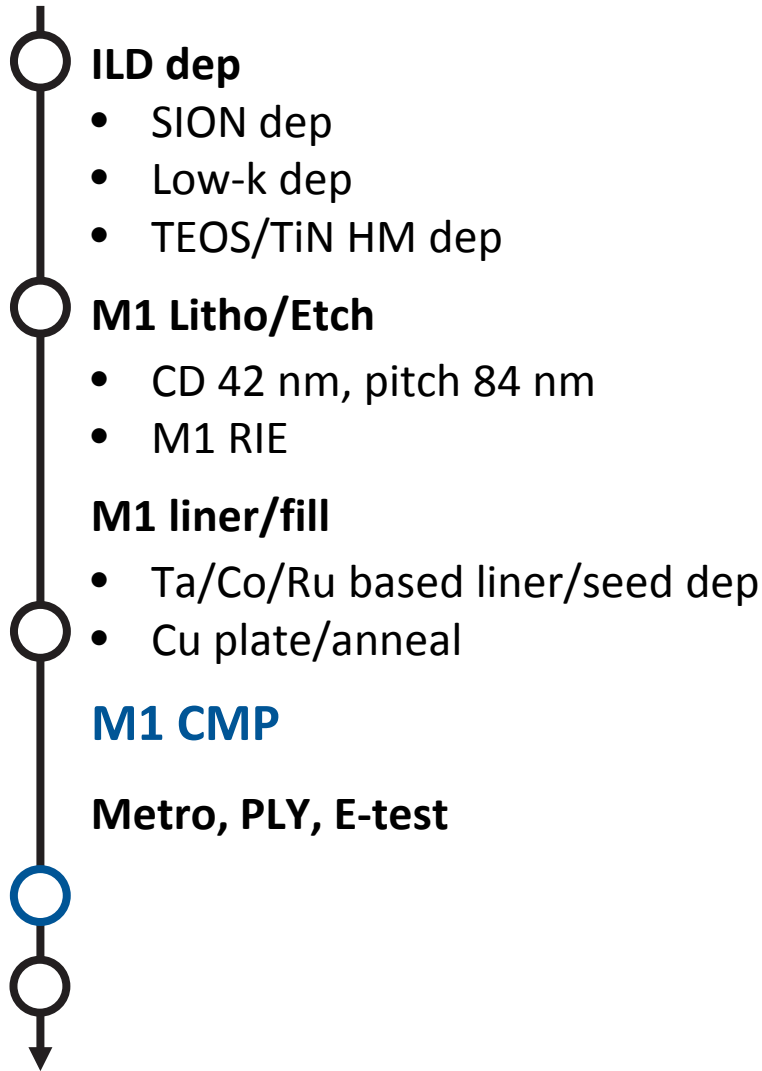
- W consumable performance and CoO evaluation

POP/W RMG flop down



- Consumable performance, CoO & defectivity evaluations

M1/Cu Damascene



Next generation liner and interconnect materials

STI and replacement fin

HM dep and litho

- Current - CD 18 nm, pitch 200 nm
- Future - CD 18nm, pitch 80
- SIT- CD - <10, pitch 40nm

Fin/Active Etch

- Fin etch

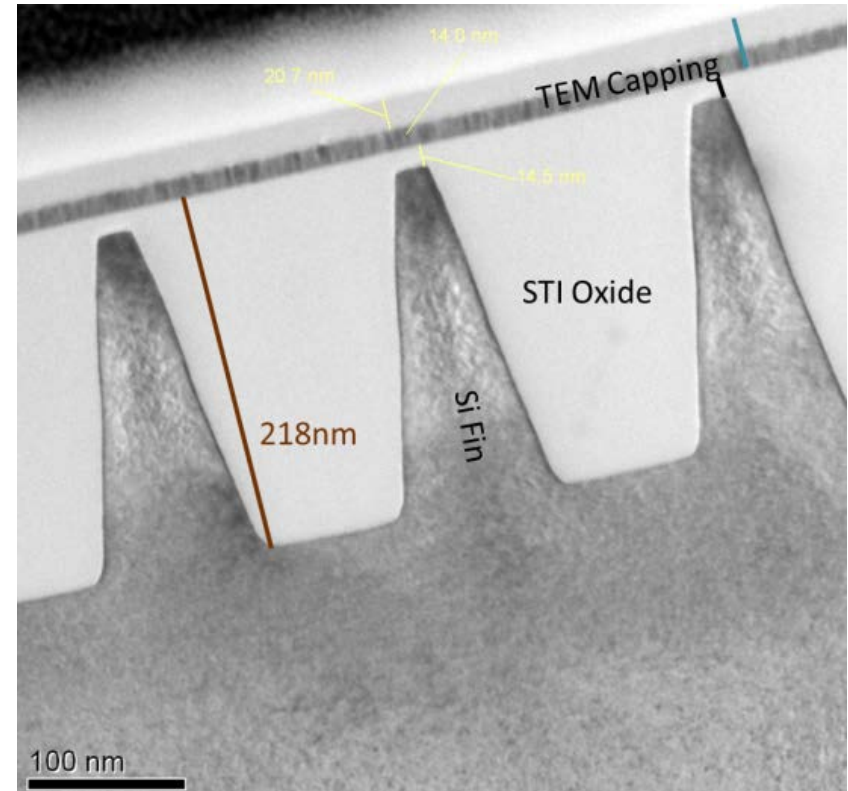
Shallow Trench Isolation

- Oxide dep (HARP, flowable Ox, HDP) and anneal
- **CMP**
- Metro, PLY

Fin Release

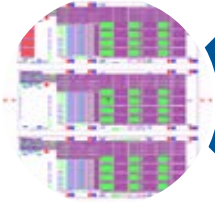
Replacement fin

- Dummy fin etch/clean
- III-V and Ge selective epi
- **CMP**
- Metro, PLY



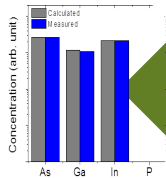
Applications: non-planar STI consumables optimization, high-mobility replacement fin consumable development

Planarization Center Focus Areas



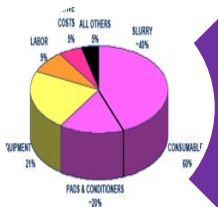
Industry Standard Mask-set

- Characterization of new consumables at relevant critical dimensions
- Updated dummy-fill / cheesing rules enabled by new consumables



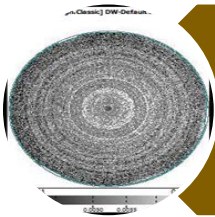
ESH

- III-V outgassing and waste water treatment
- Nano-particle toxicity



Cost of Ownership Improvement

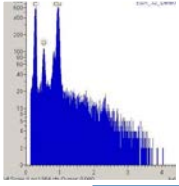
- Slurry volume reduction, pad-life improvement, Break-in improvements
- Waste-handling improvement, Recycled DIW
- Scale up to 450 mm



Defect Reduction and Metrology

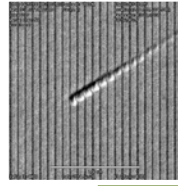
- Advanced process control using hybrid metrology techniques
- Multi-spectral defect characterization

Partner / Center Interaction Areas



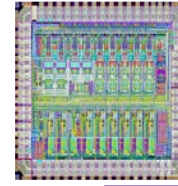
Consumables Vendors

- Consumable lifetime studies – defectivity, performance
- Characterization of consumable degradation, mechanism studies
- Break-in/CoO improvements
- Pad/Slurry/low-k dielectric interactions
- New materials defectivity characterization
- Advanced particle size analyses
- Post-CMP clean chemistry for novel materials



Equipment Vendors

- New material ESH
- Slurry delivery systems
- Improved filtration
- Killer particle identification
- Improved in-situ metrology
- New defect characterization techniques
- Novel post-CMP metrology techniques
- Novel post-CMP clean technologies



IDM / Design Tools

- Characterization of CMP of new materials and necessary design rules
- Updates to existing design rules enabled by new processes
- Node-relevant 'BKM' processes developed at the Center by vendor-groups
- Industry-standard mask-set for easier performance comparison

CMP Ecosystem Survey

- SEMATECH will conduct a survey to determine:
 - Prioritized industry challenges
 - Mask-set design requirements
- Please contact richard.hill@sematech.org to participate

Contact Info

- Booth Located in South Hall #517
- Business Contacts
 - Frank Tolic: Associate VP for Business, Wafer Processing. CNSE
ftolic@albany.edu
 - Edward Barth: Director of Strategic Growth Initiatives. SEMATECH
edward.barth@sematech.org
- Technical Contacts
 - Satyavolu Papa Rao: Director of Process Technology. SEMATECH
satyavolu.paparao@sematech.org
 - Brett Baker O’Neal: Manager, CMOS Process Development. CNSE
bbaker-oneal@albany.edu
 - Christopher Borst: Associate VP for G450C Technical Operations; Associate Professor of Nanoengineering. CNSE
cborst@albany.edu
- Survey
 - Richard Hill: Manager Technology Infrastructure. SEMATECH
richard.hill@sematech.org