Hard Porous Pad™ for Copper Low K CMP

Guangwei Wu, Long Nguyen, Galvez Pepito, and Tom West

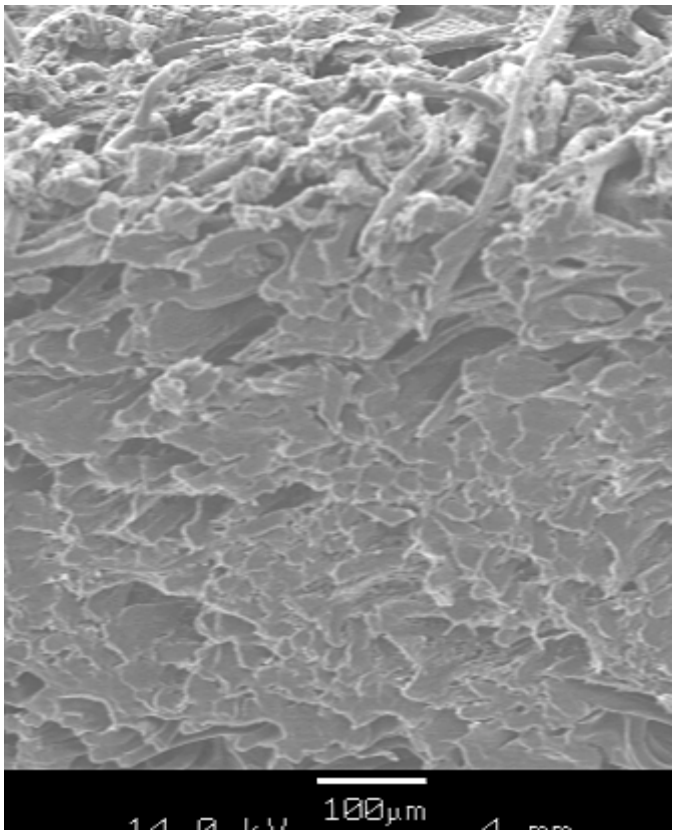
Thomas West, Inc. 470 Mercury Dr. Sunnyvale, CA 94085

Outline of the Presentation

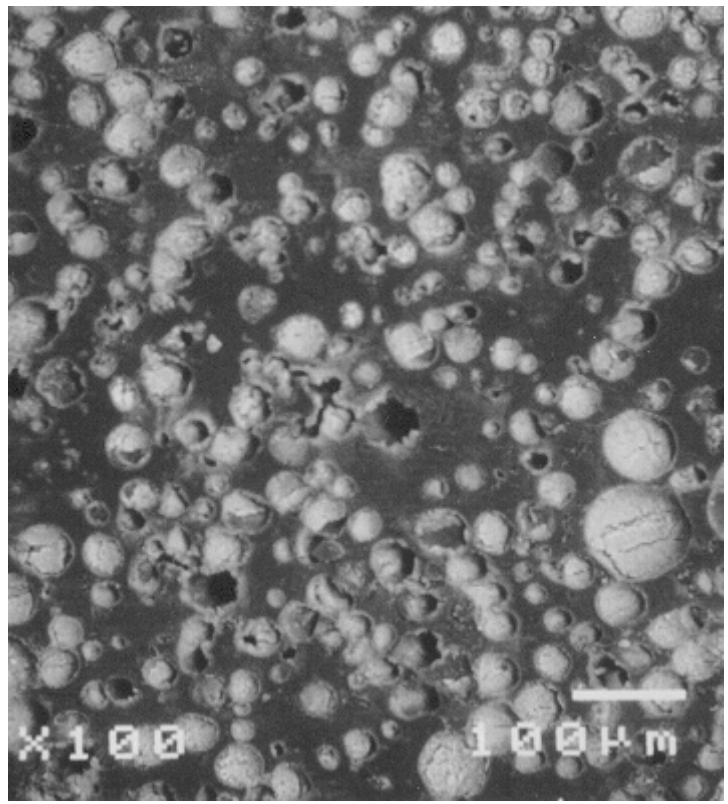
- TWI Hard Porous Pad™
- Planarization Capability
- Challenge of low K CMP
- Information of low K wafer
- Results of low K wafers
  - Surface finish
  - E-test results
- Summary

Appearance of Pads

TWI's Hard Porous Pad



Rodel's IC1000

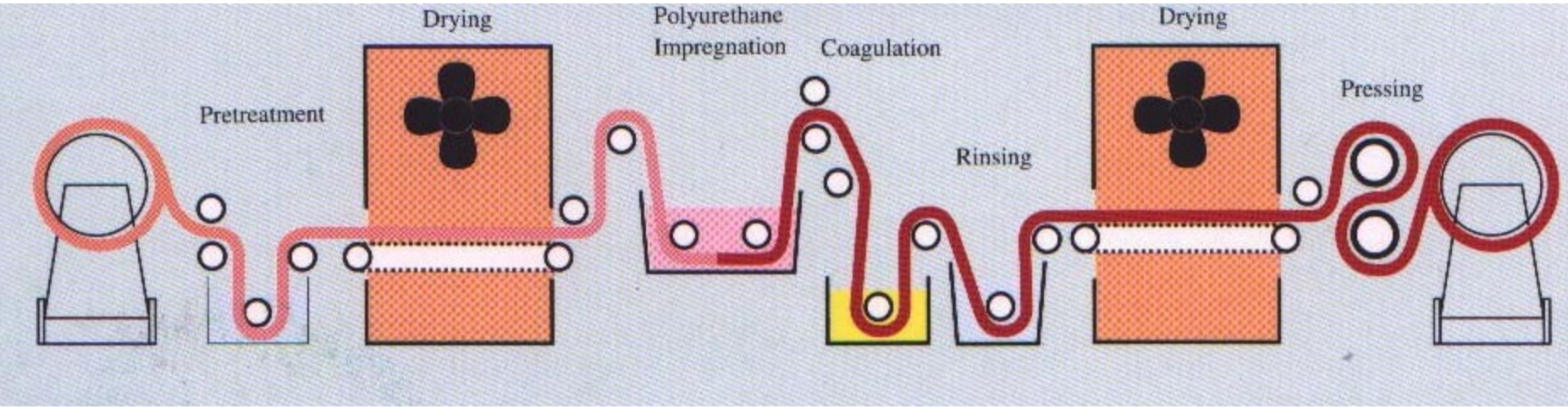


Physical Properties

Property	Hard Porous Pad	IC 1000
Thickness / mm	1.2	1.3
Hardness / shore D	51 – 57	52 - 62
Density / g/cm^3	0.61	0.75
Compressibility / %	2.2	2.1
Rebound / %	75	73
Modulus / Mpa	250*	300 **
Pore Size / μm	10 - 100	10 -80

* Bulk modulus from compression measurement; ** storage modulus from DMA @ 40 ^{o}C.

Manufacturing Method of Hard Porous Pad



Single layer and continuous manufacturing

Consistency is not limited by technology (sheet vs cake)

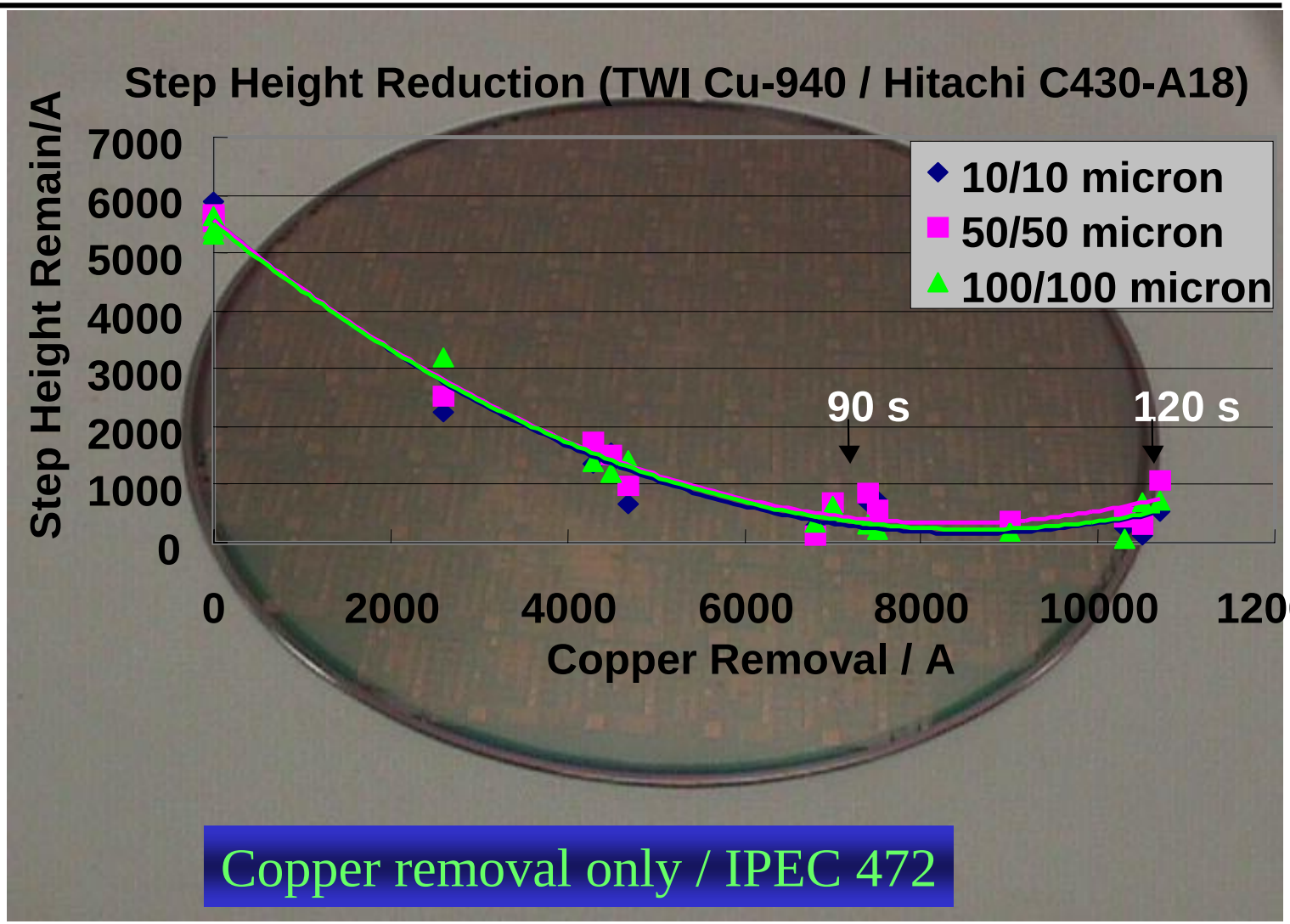
Effect of Pad Properties on Polishing Performance

- Removal rate:
  - slurry transport; slurry retention capability
- NU
  - Slurry transport; pad hardness; compressibility
- Defectivity
  - Pad hardness; capability to remove polishing residue
- Planarity / dishing - erosion
  - Pad hardness; modulus; stiffness
- Pad life
  - Conditioning method, thermal stability

Features of Hard Porous Pads

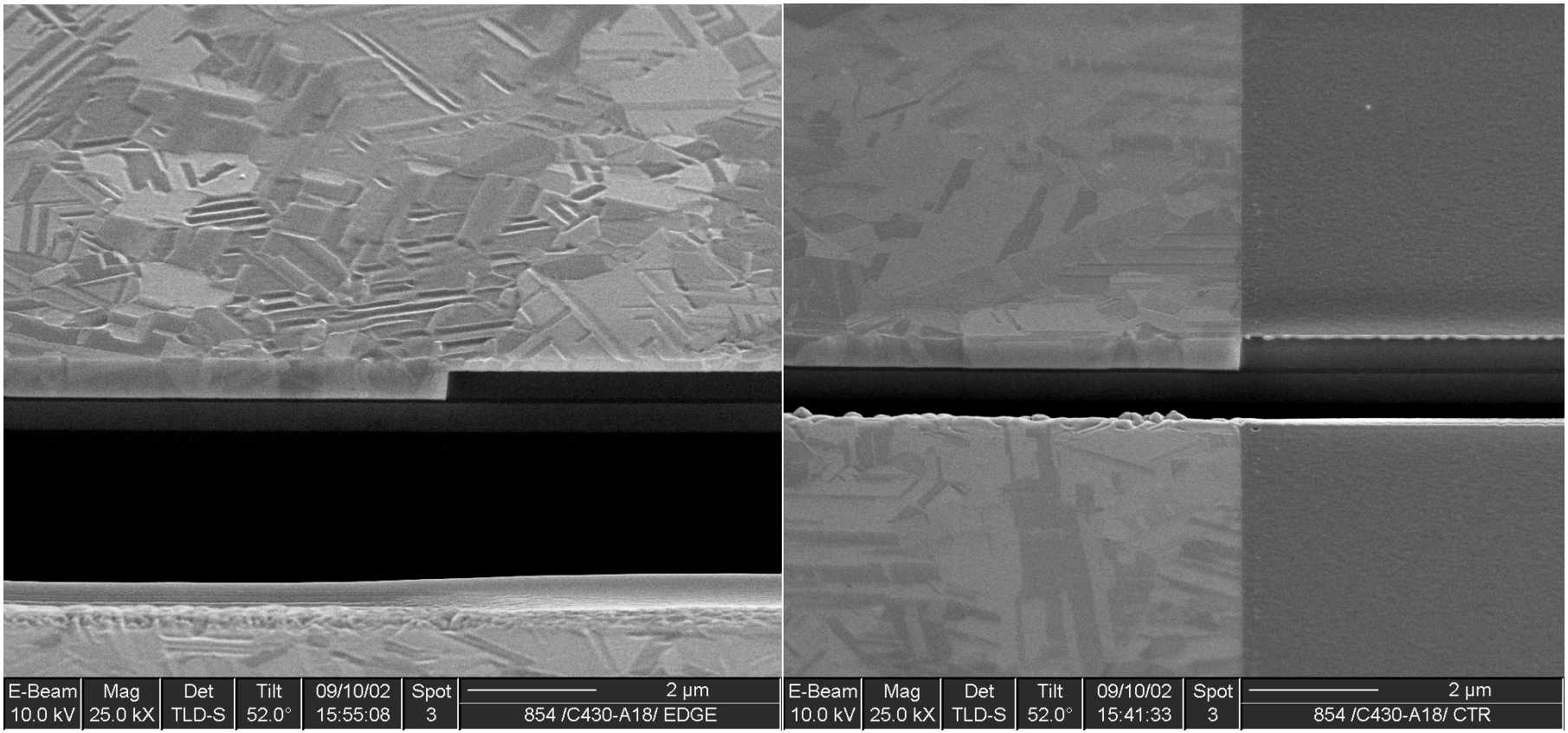
- Excellent lot-to-lot, pad-to-pad consistency
- Open pore structure improves slurry transport
  - Can operate at significantly lower flow rate
  - Better non-uniformity
- Open pore structure becomes easier to remove polishing residue
  - Lower defect
- Requires minimal break-in and conditioning
  - Reduce tool down time
  - Extend conditioner lifetime
  - Longer pad life

Step Height Reduction



Copper removal only / IPEC 472

SEM Cross-Section Profile



50 / 50 micron structure

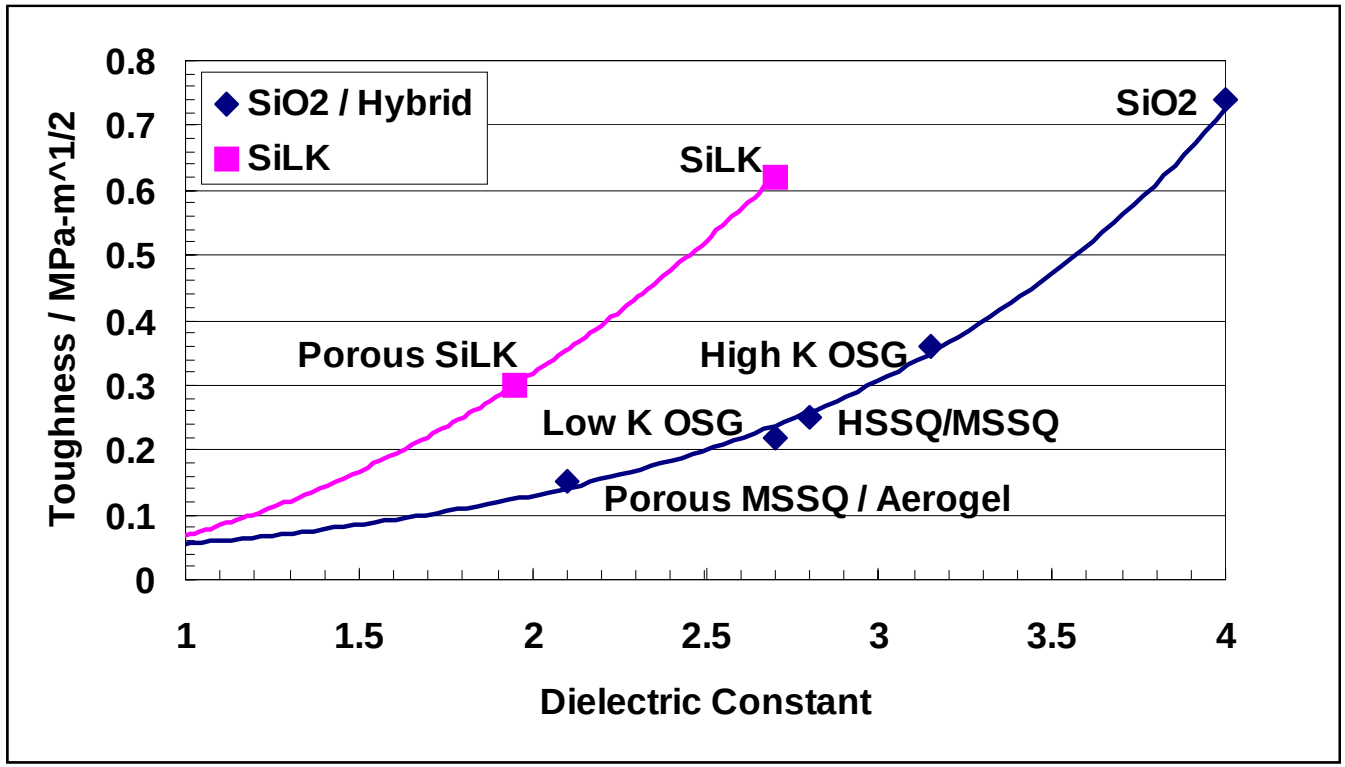
Dishing and Erosion

Copper polish: Hitachi C430-A18 (4 psi / 110 rpm)
Barrier polish: Planar 10K-2 (2 psi / 110 rpm for 60 s)

Structure (L/S)	Copper polish	Barrier polish
100 X 100	800	<300
50 X 50	700	<200
9 X 1		<200
1 X 1	<200	<200

Results are average of center, mid, and edge die

Challenge of Low K CMP



M. Mills & M. McClear: *Future Fab Int.* Vol 11

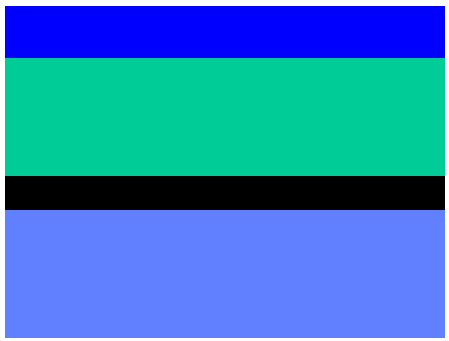
Adhesion: barrier / cap; cap / low K; low K / hard mask

Mechanical failure: crack; high defect;

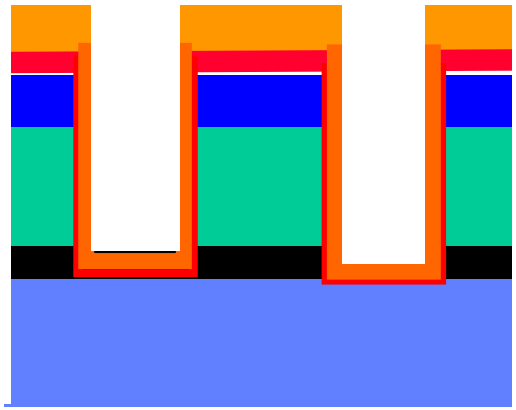
Low K Material Properties

Parameter	Spin-On Low K	Method
Type	Inorganic - Porous	
Dielectric Constant	2.2	CV Dot at 1 MHz
Modulus	3.50 +/-0.1 (0.6µm)	Nanoindentation
Hardness	0.35 +/-0.02 (0.6µm)	Nanoindentation
Pore Size (Average)	2.0 nm	BET
Stability at 425°C	<1%	ITGA at 425°C (%/hr) post cure in N2 ambient
Stress	20 MPa ; Tensile	Flexus
CTE	10 ppm/°C	In-Plane Wafer Curvature

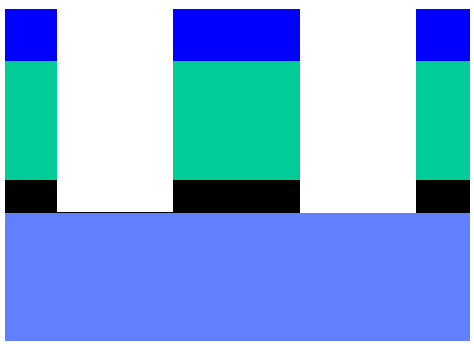
Integration Scheme for Porous Inorganic Low K



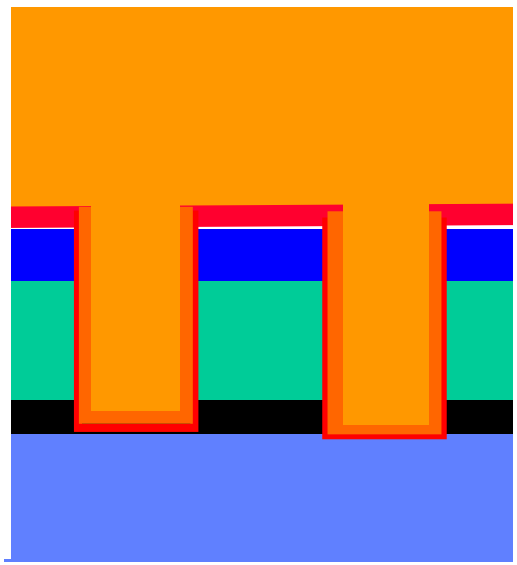
TEOS
Low K
SiN



Cu seed
Barrier
TEOS
Low K
SiN



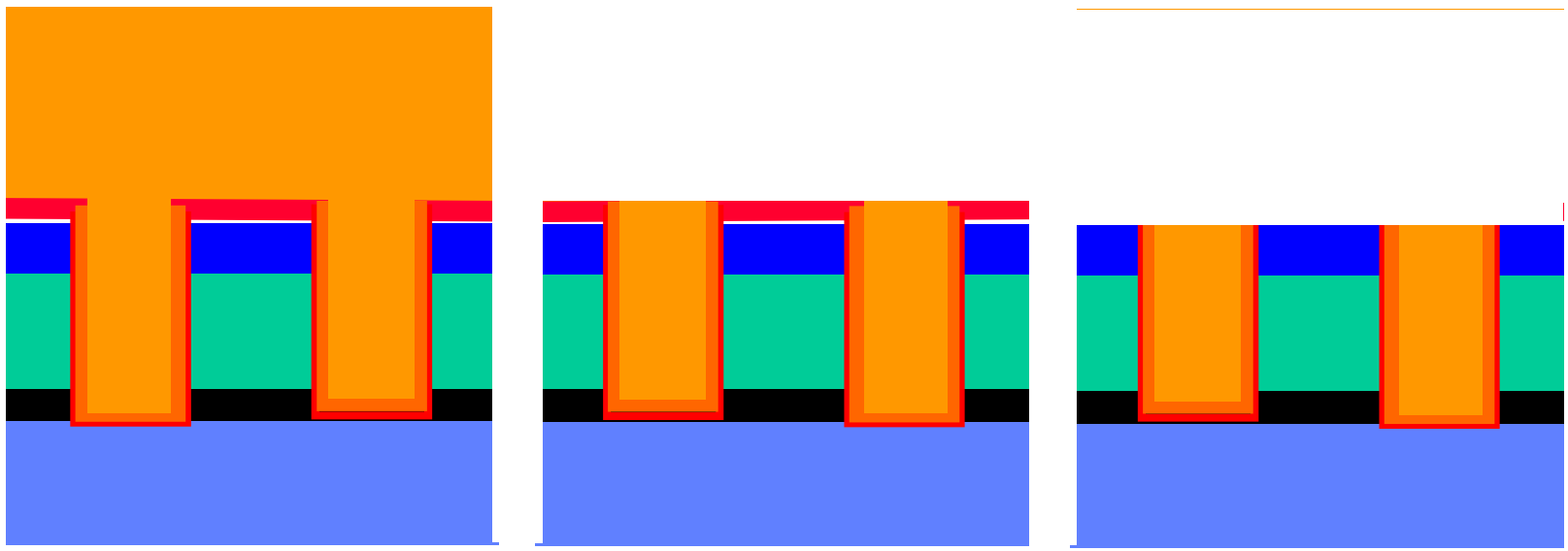
TEOS
Low K
SiN



EP Cu
Cu seed
Barrier
TEOS
Low K
SiN

CMP Process

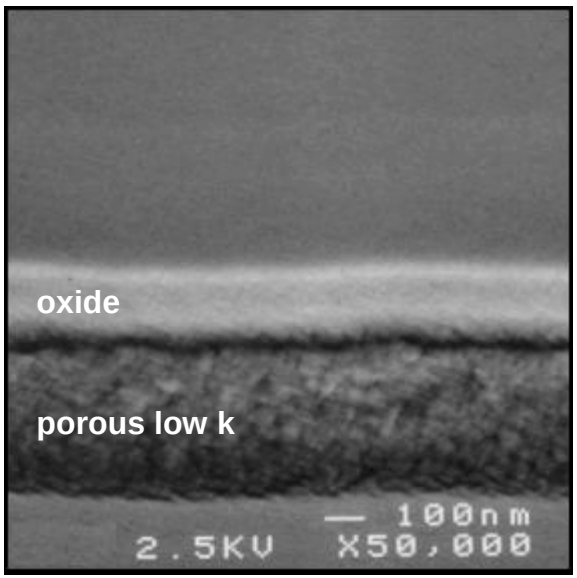
EP Cu
Cu seed
Barrier
TEOS
Low K
SiN



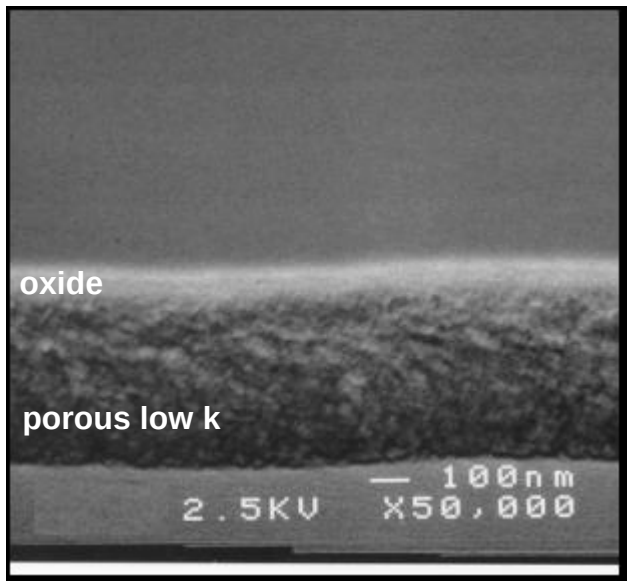
Copper Removal
Cabot 5003
2.5 psi / 110 rpm

Barrier Removal
Planar 10K-2 / HS T805
2 psi / 110 rpm

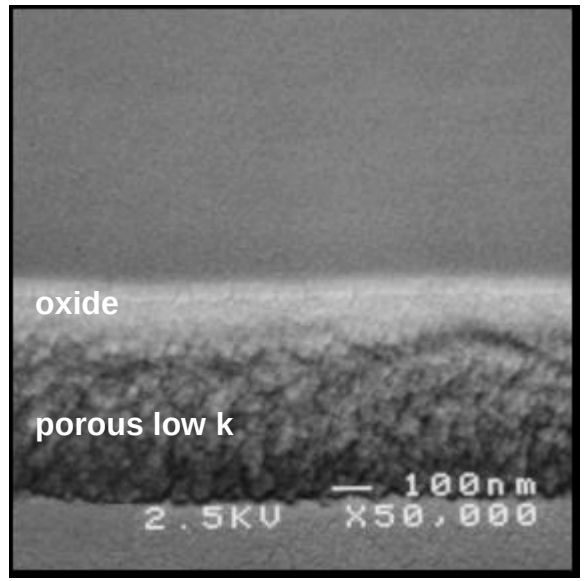
Direct CMP of Blanket Porous Low K Films



Pre-CMP



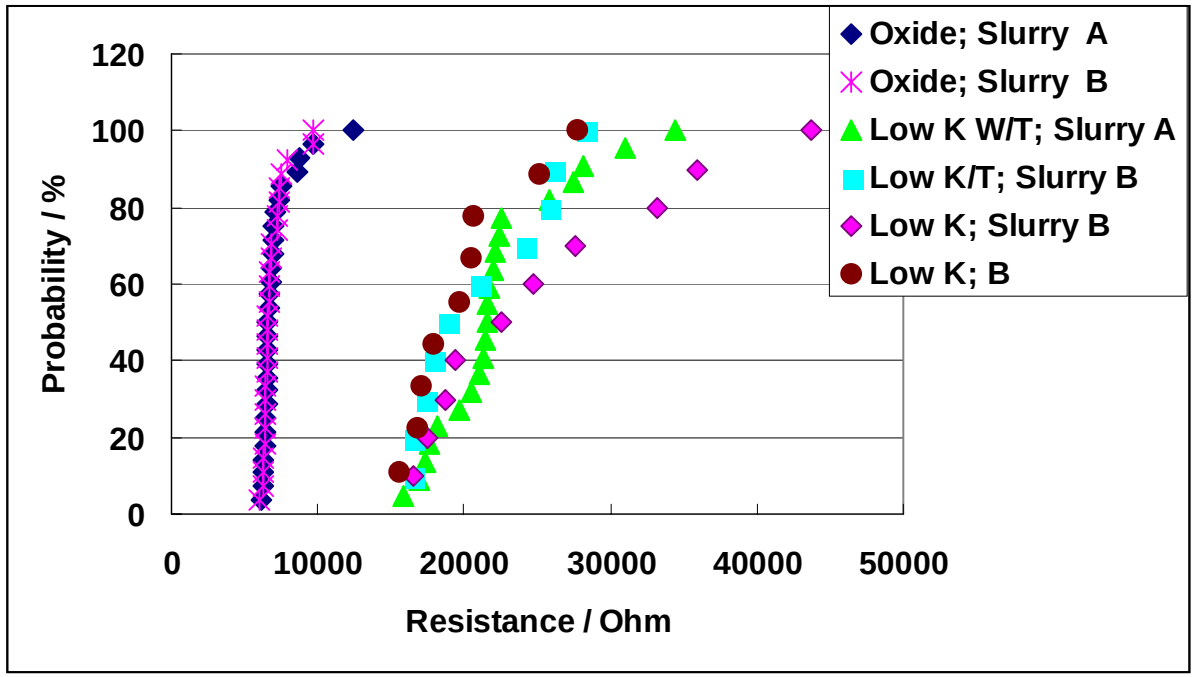
Hitachi T805



Planar 10k-2

- Good adhesion observed between porous low k and oxide cap with barrier slurry polish.
- No scratches observed after CMP

Snake Resistance (0.24 / 0.24 micron)



The absolute resistance difference is due to trench depth. The median resistance of low K is proportional to that of oxide wafer. Barrier slurry has minor effect on distribution profile.

Summary

- Hard Porous Pad has been successfully used for copper / low K CMP
  - Good dishing and erosion
  - Good surface finish
- Hard Porous Pad is compatible with different slurries
  - Different barrier slurries has minimal effect on resistance