Chemical Mechanical Polishing of Divinylsiloxane-bis-benzocylcobutene (DVS-BCB or BCB) low –k Interlevel Dielectric Polymer

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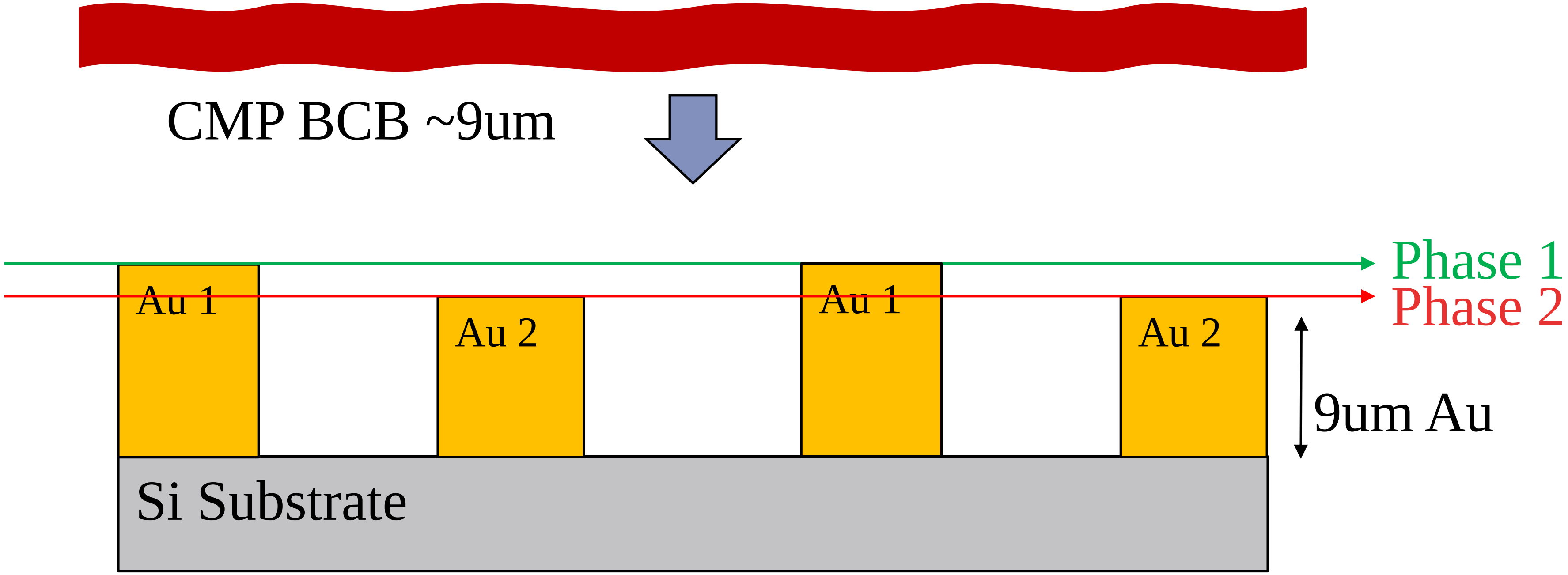
1-Step, 2 -phase planarization (Bulk Removal - BCB/AU Matrix)

- Ti/Au Seed
- Photolithography
- Patterned Electroplating
- Strip
- Deposition of BCB



CMP BCB ~9um

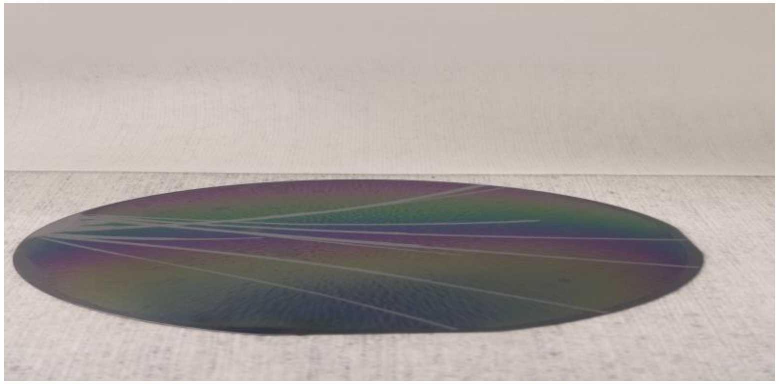
BCB material selection

- Spin-on polymer used for low–k ILD
  - Low Dielectric Constant (k) (~2.65); SiO2 is 3.9
    - Leads to low conductance loss on vertical interconnects for smaller devices.

- Good Planarity for Bond III-V to SOI structures.
  - Spin on
  - Easy to manufacture

Benchtop Tool Testing

Process	Pad	Conditioner	Slurry Particle	Result
Lapping	Radial Groove Glass	None	9um Al_2O_3	Local delamination, immediate failure
Polishing	Fujimi Surfin 019-3	None	.2um ZrO_2	Local delamination and scratches

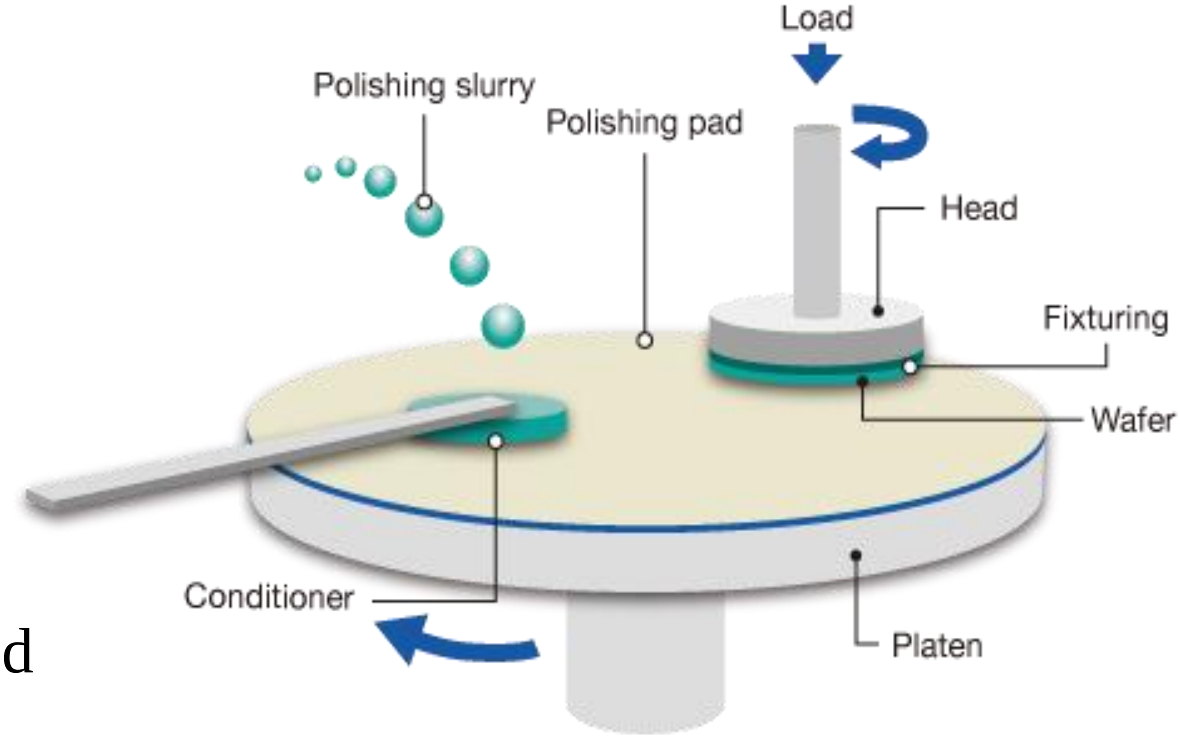


- Bulk removal on benchtops were insufficient and failed.

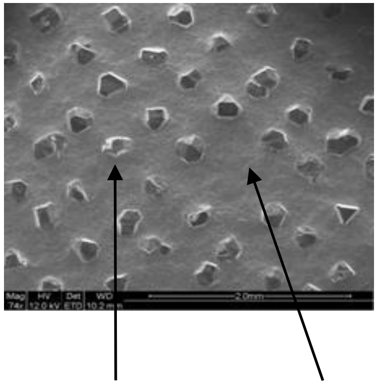
CMP PROCESS

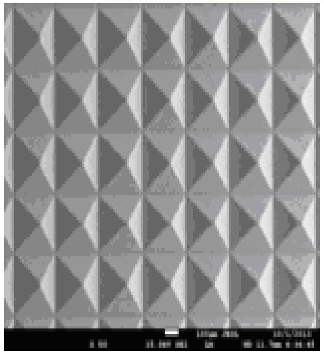
Process Variables

- Slurry Types
    - Silica
    - Al_2O_3
- Conditioner
    - Diamond Grit
    - Microreplicated

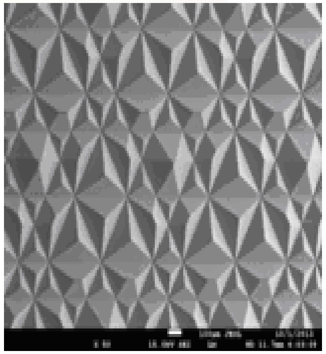


Diamond Grit vs. Microreplicated





M1



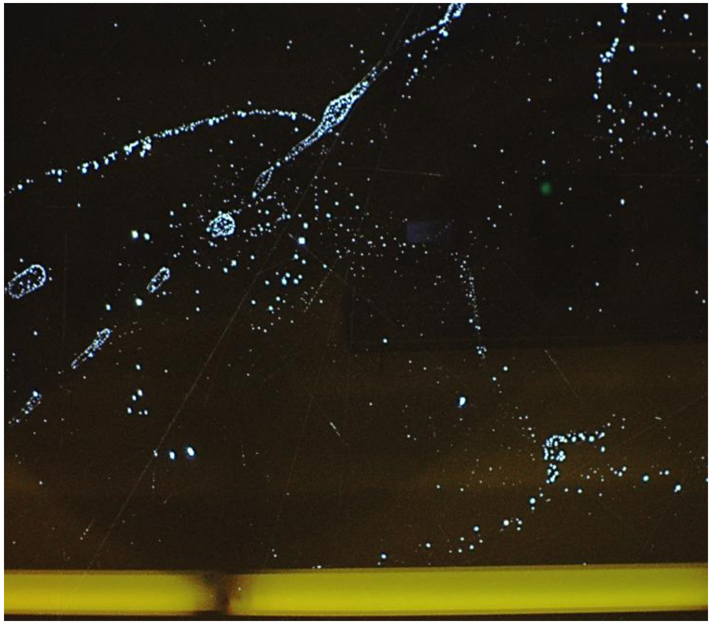
M2

Diamond Metal matrix

CVD Diamond

Zabasajja, John et al. "Advanced CMP Conditioning for Front End Applications,"*2015 International Conference on Planarization/CMP Technology*. Chandler, AZ, 2015

DF inspection show Microreplicated decreases surface damage



Scratching and slurry defects with Diamond Grit disc

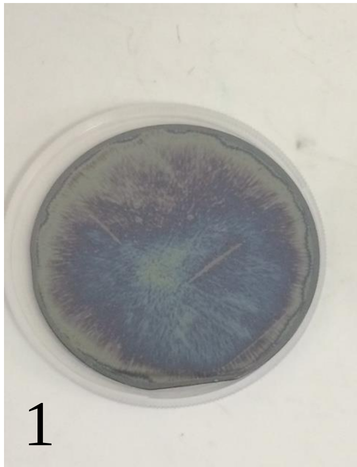
Clean Surface With Microreplicated M2 Disk

Particle Size drives bulk removal
Conditioner affects Au finish

Exp	Slurry	Size (um)	pH	Cond. Disc	Removal Rate (nm/min)	Unif (%)
1	Silica	.07	7.3	M1	13.4	2.1
2	Silica	.07	2	M2	5.56	.7
3	Silica	.12	10.7	M2	45.7	.54
4	Al_2O_3	.24	4.1	Diamond	120	>30
5	Al_2O_3	.24	4.1	M1	310	2
6	Al_2O_3	.24	4.1	M2	308	<2

M1 and M2 Conditioner discs perform similarly during Phase 1 (Bulk BCB removal)
M1 removal insufficient during Phase 2 (Gold removal).

Slurry selection drives the process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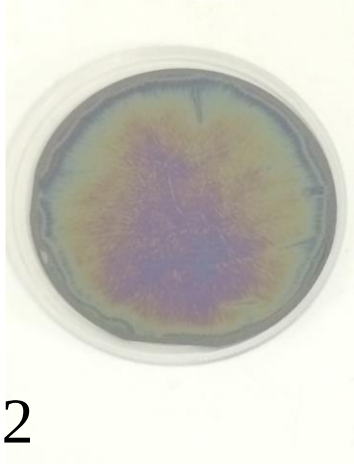
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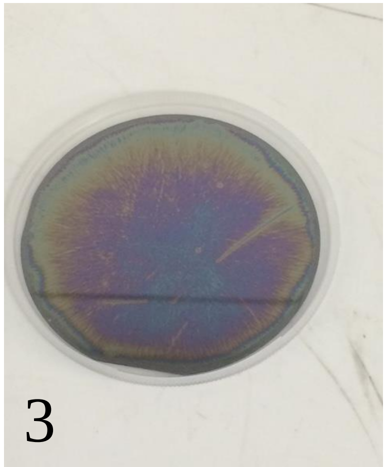
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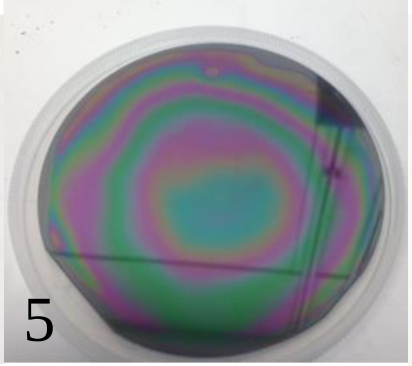
Silica Slurries are insufficient, causing chunking and tearing


4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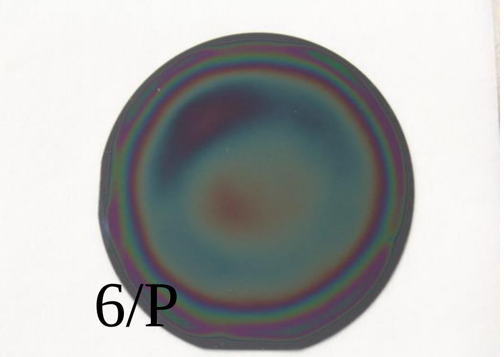
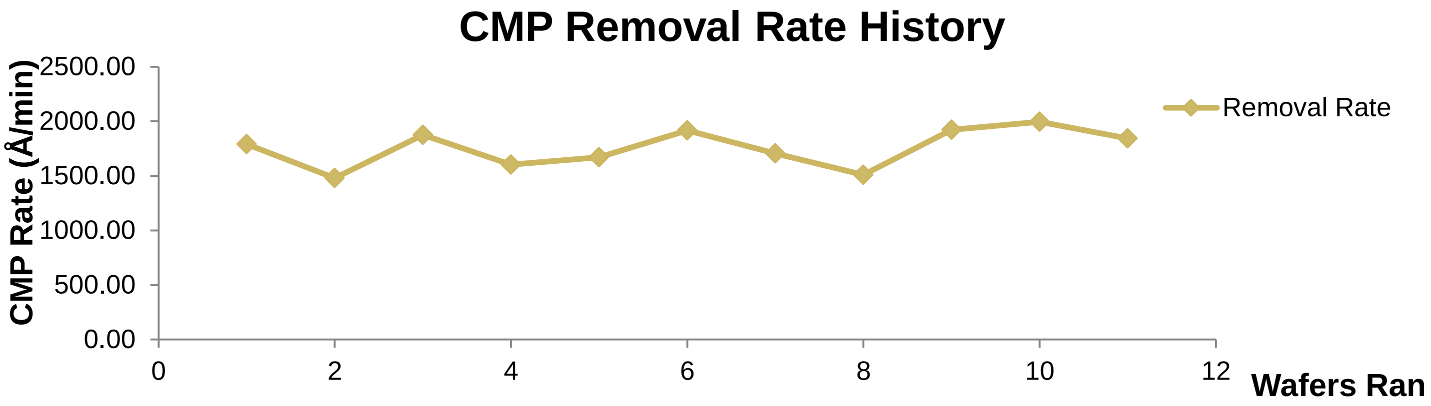

6/P

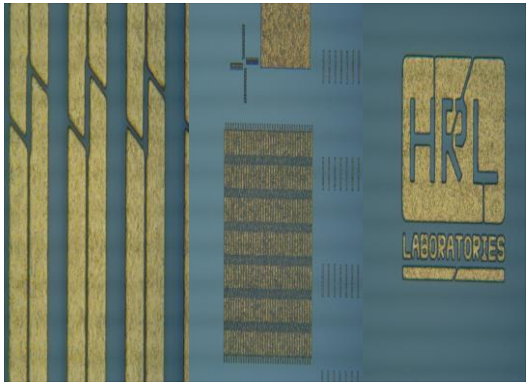
Al_2O_3 Slurries have radially uniform removal optimized by conditioner selection and recipe variables.

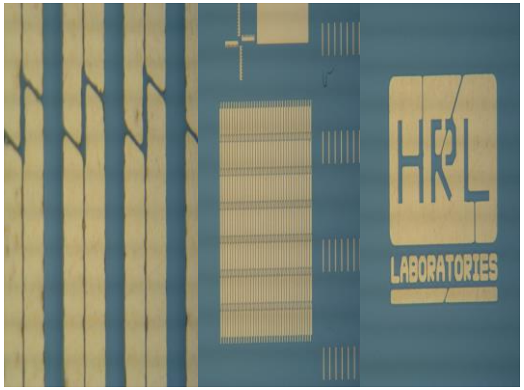
Process was adjusted and repeated before production rollout



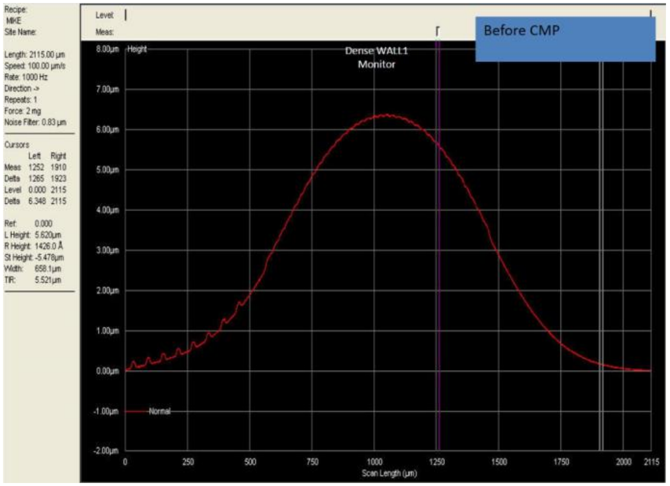
Exp	Slurry	Conditioner	Removal Rate (nm/min)	Unif (%)
Blanket Wafer 1	Al_2O_3	M2	148	1.3
Blanket Wafer 2	Al_2O_3	M2	160	1.4
Patterned	Al_2O_3	M2	151	N/A

Isolated Au1 Monitor Profile





6.2um



Recipe:
MIKE
Site Name:

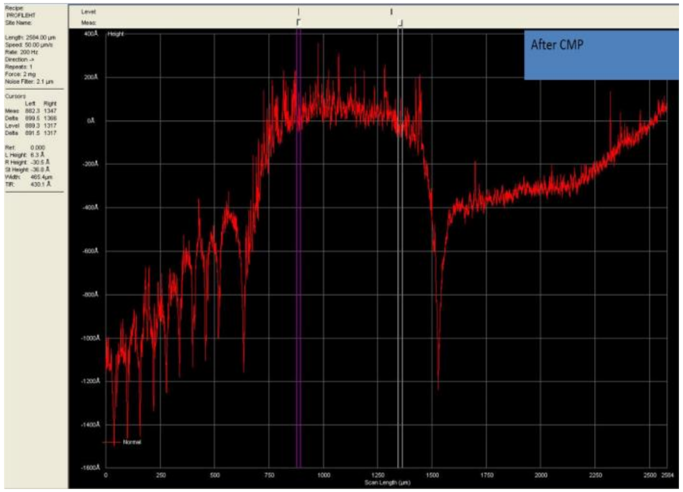
Length: 2115.00 µm
Speed: 100.00 µm/s
Rate: 1000 Hz
Direction ->
Repeats: 1
Force: 2 mg
Noise Filter: 0.83 µm

Cursors

	Left	Right
Meas	1252	1910
Delta	1265	1923
Level	0.000	2115
Delta	6.348	2115

Ref: 0.000
L Height: 5.620µm
R Height: 1426.0 Å
St Height: -5.478µm
Width: 658.1µm
TIR: 5.521µm

1400Å



Recipe:
PROFILEHT
Site Name:

Length: 2584.00 µm
Speed: 50.00 µm/s
Rate: 200 Hz
Direction ->
Repeats: 1
Force: 2 mg
Noise Filter: 2.1 µm

Cursors

	Left	Right
Meas	882.3	1347
Delta	899.5	1366
Level	889.3	1317
Delta	891.5	1317

Ref: 0.000
L Height: 6.3 Å
R Height: -30.5 Å
St Height: -36.8 Å
Width: 465.4µm
TIR: 430.1 Å

Al_2O_3-Microreplicated-Process planarized 6um of BCB and Au

CONCLUSIONS

- Benchtop processes (Lap/Polish) were too aggressive and caused full film delamination.
  - CMP yielded measurable removal rates without immediate failure.
- Al_2O_3 slurry yielded the highest removal rates.
  - Silica slurries were insufficient for bulk material removal and resulted in tearing of the BCB.
- The Microreplicated disc (M1 and M2) yielded better uniformity and control than diamond grit.
  - Less scratching from particles and residue.
  - M2 is more aggressive than M1 and showed better pad refreshment and longer pad life.

ACKNOWLEDGEMENTS

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