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Hitachi Chemical Metal CMP Slurry and Low-K Material

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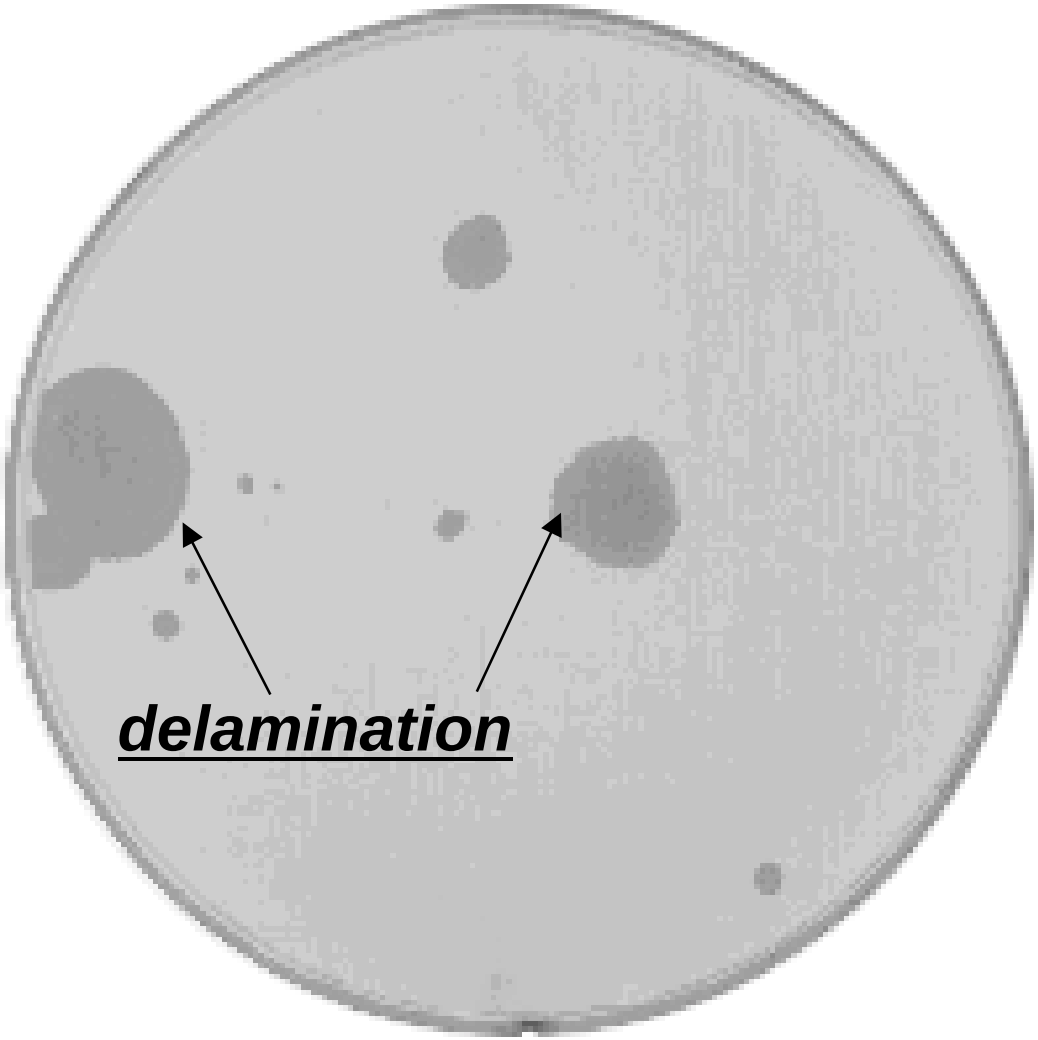
Delamination

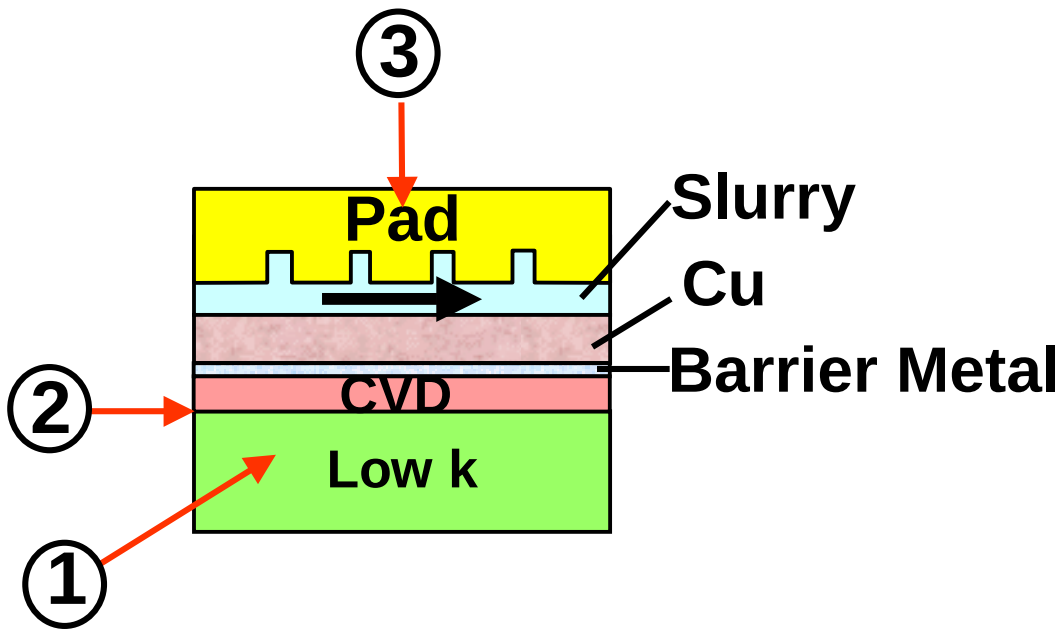


Why delamination happens ?

① Low mechanical strength of Low k material

② Poor adhesion between Low k and CVD

③ High down force Cu polishing



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Hitachi Chemical Cu / Low-k Integration Process Solution

Cu-CMP slurry

- Low down force polishing

Low-k material

- High mechanical strength

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Appearance of Abrasive Free Polishing (AFP) solution

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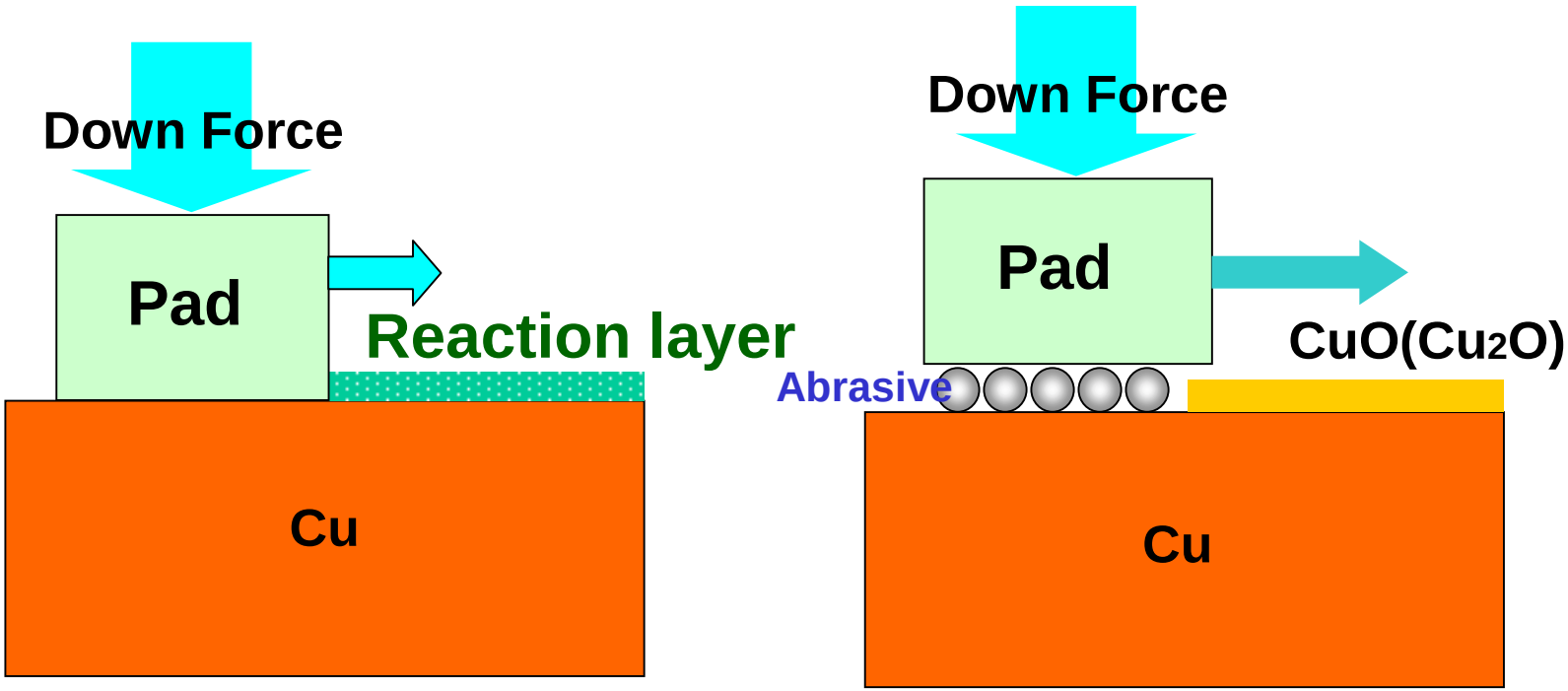
Polishing Model



Abrasive Free

Polishing pad shear force

Conventional

Abrasive powder

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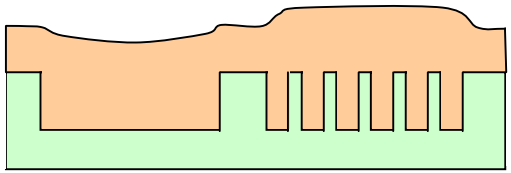
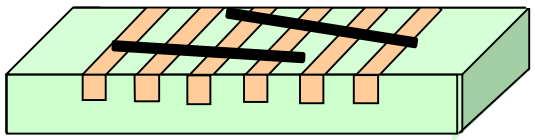
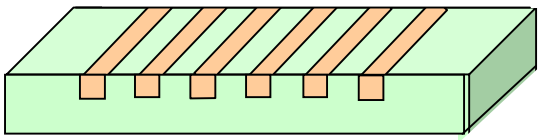
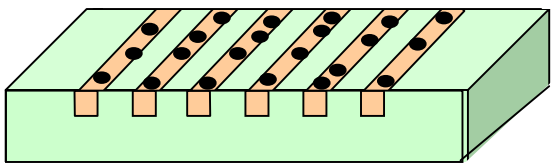
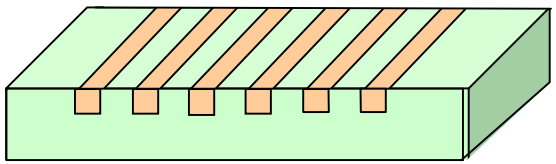
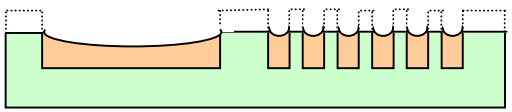
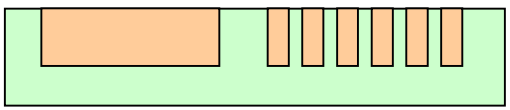
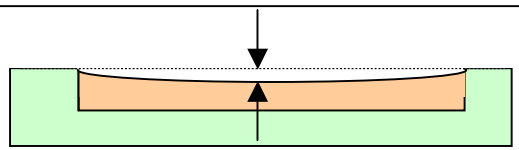
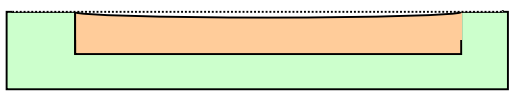
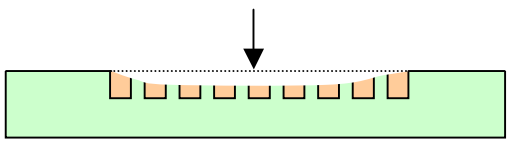
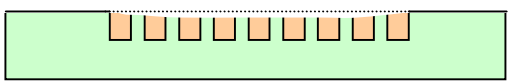
Advantages of AFP

Item	Conventional	Abrasive Free	Merit
———			———
Micro Scratch			Increase in Yield
Particle Residue			Increase in Reliability
SiO_2 Loss			Designed Resistivity
Dishing			Designed Resistivity
Erosion			Designed Resistivity

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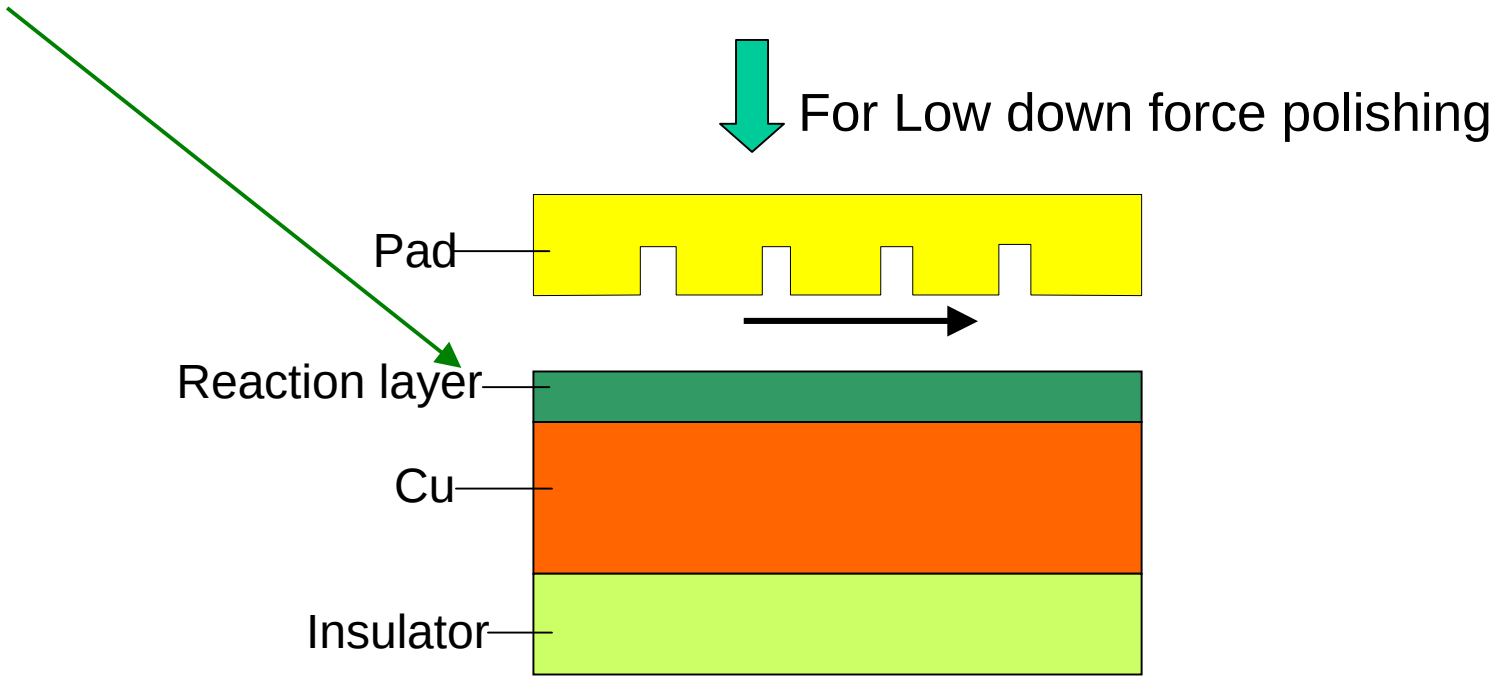
Concepts of Cu slurry for Low-k

Change reaction layer with new formulation

The structure, hardness, thickness & formation speed are optimized



HS-C500-X

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Performance of new Cu slurry (HS-C500-X) for Low-K

Items			Target	HS-C500-X
Feature			-	High RR High planarity Low Friction
Friction* (vs conventional on: 100)			-	63 a.u.
Removal Rate (Ang./min) (NU:1sig.%)	Cu	1.5psi	> 5000	5350
		2.0psi	> 5500	7400
Dishing(Ang.,100um/100um)			< 500	500 ***
Cu Loss**(Ang.,9.0/1.0um)			< 500	500 ***
Cu Residue			None	None

*: Estimated value from pad temp.**: Erosion+Dishing, ***: DF = 2psi, Wafer: Sematech 854, OP=30%

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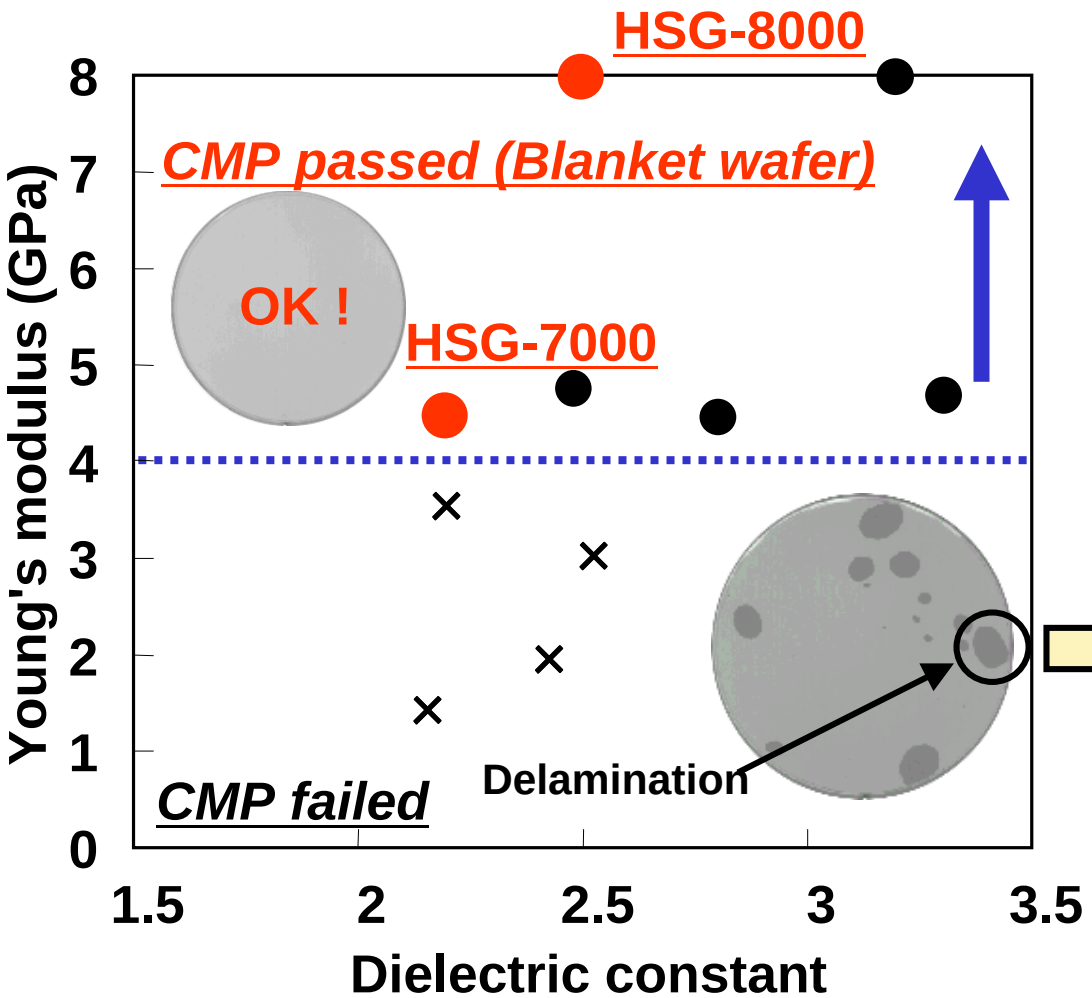
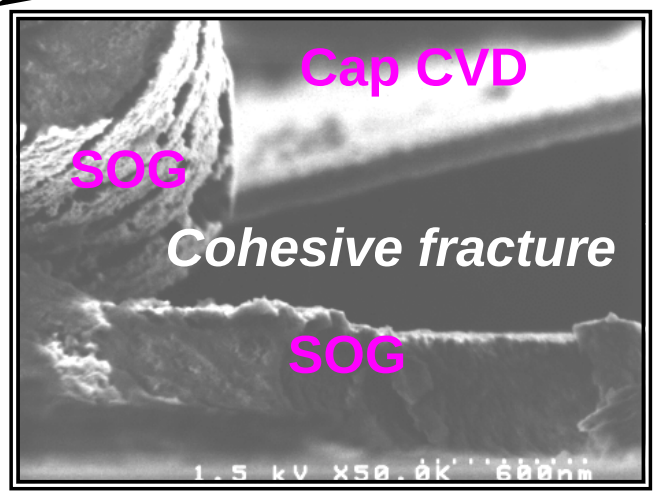
Influence of Young's modulus on Cu-CMP



Requirements for low k

1) Bulk k : ≤ 2.2
2) Modulus : > 4GPa
3) Good Adhesion to CVD (Selection of CVD film)



Cross Sectional SEM

Courtesy of Hitachi Central Research Laboratory

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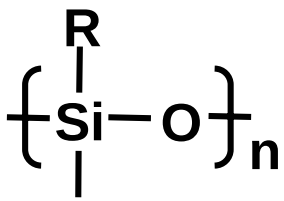
Concepts of HSG-7000

HSG-7000



R: organic group

Spin-on Dielectric
Siloxane Polymer
Porous Material
$k \leq 2.2$

Material Design Concepts

- **Process Compatibility**
- **Low Organic Content**
- **Low Pore Volume**
- **Narrow Pore Size Distribution**

→

Good Process Compatibility

- **High Mechanical Strength**
- **Cu-CMP Resistivity**

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Film Properties of HSG series [1)]

Property	HSG-7000	HSG-R7	Methodology
Type	Porous	Non-Porous	—
Dielectric constant	2.2	2.8	CV@1MHz
Young's modulus [GPa]	4.3	4.4	Nano-indentation [2)]
Weight loss [%]	< 1	< 1	Isothermal TGA, 425ºC, 2h
Out-gassing (relative value)	0.6	1	TDS
Crack Threshold(mm)	> 2.5	1.5	—

1) Cure conditions : 400 ºC / 30min under N2 atmosphere
2) Nano-indenter DCM by MTS

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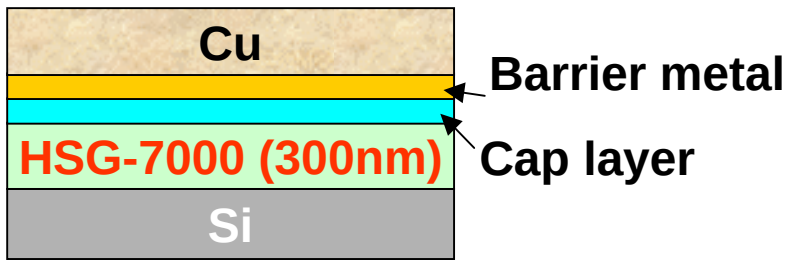
Cu-CMP Process

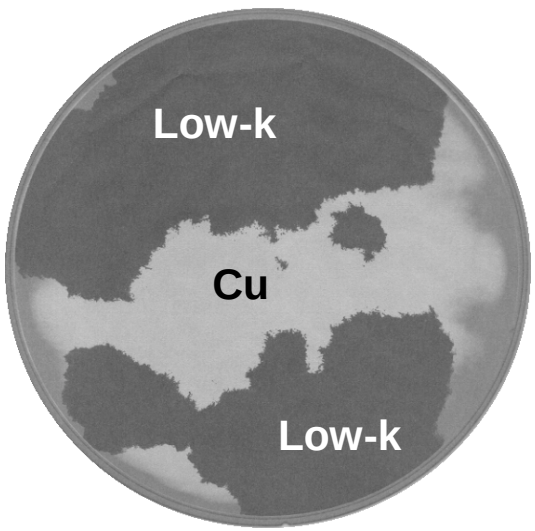
— Combination of HSG-7000 with HS-C500-X —

- **Slurry :**
  HS-C500-X
- **Polisher :**
  Conventional Rotary type Polisher

- **Structure (Blanket wafer)**



Conventional (E = 2.0GPa)



HSG-7000 (E = 4.3GPa)

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Summary

(1) Abrasive free Cu-CMP slurry has successfully developed.

(2) Cu CMP slurry which can achieve low down force polishing is newly formulated.

(3) HSG-7000 which has high mechanical strength is developed though Cu-CMP test.

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