

A decorative graphic consisting of a red, stylized, overlapping geometric shape, possibly representing a folded piece of paper or a ribbon, positioned on the left side of the slide.

KNOWLEDGE
CREATIVITY
TECHNOLOGY

Advanced Colloidal Ceria Slurry Challenges

2019. 04. 04.

Material R&D Center

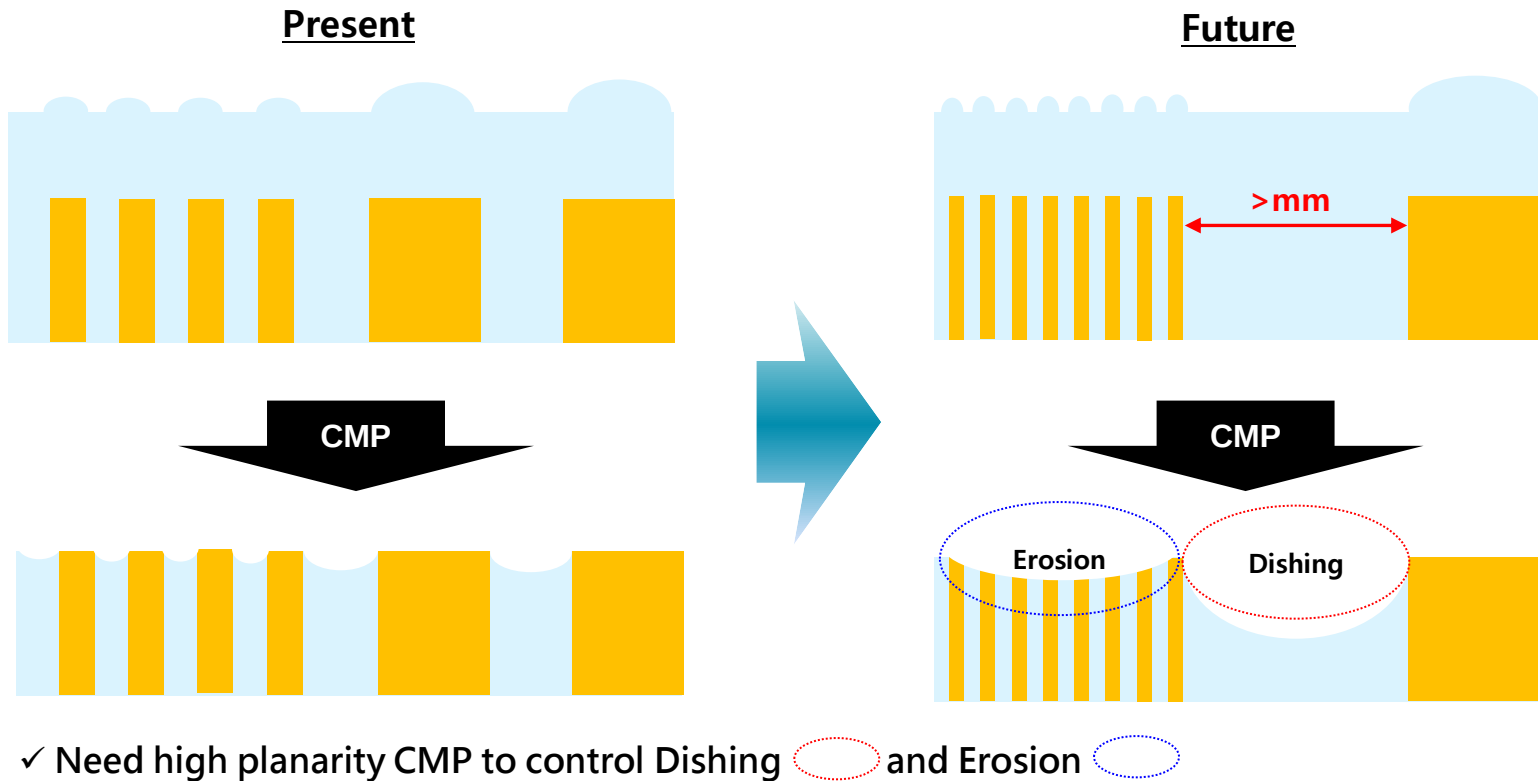
- 1. High Planarity CMP**
- 2. Next Generation Ceria Slurry**
- 3. Colloidal Dispersion Stabilization**
- 4. Positive & Negative Dispersion Ceria Slurry**
- 5. Concept & Mechanism of KCTech Colloidal Ceria Slurry**
- 6. Properties**
- 7. CMP Performance**
- 8. Summary**

1. High Planarity CMP

❖ Why High Planarity CMP ?

Device is more Shrunk & Complicated

→ Difficult to control Dishing at High Density Pattern & Wide Width Trench



2. Next Generation Ceria Slurry

❖ Performance

- Suppress Dishing : $<100\text{\AA}$ @50/50um
- Scratch Free
- High Selectivity : Multi Selectivity (SiN & Poly Stop)
- High Removal Rate (Controllable)

❖ What is the Control Parameters?

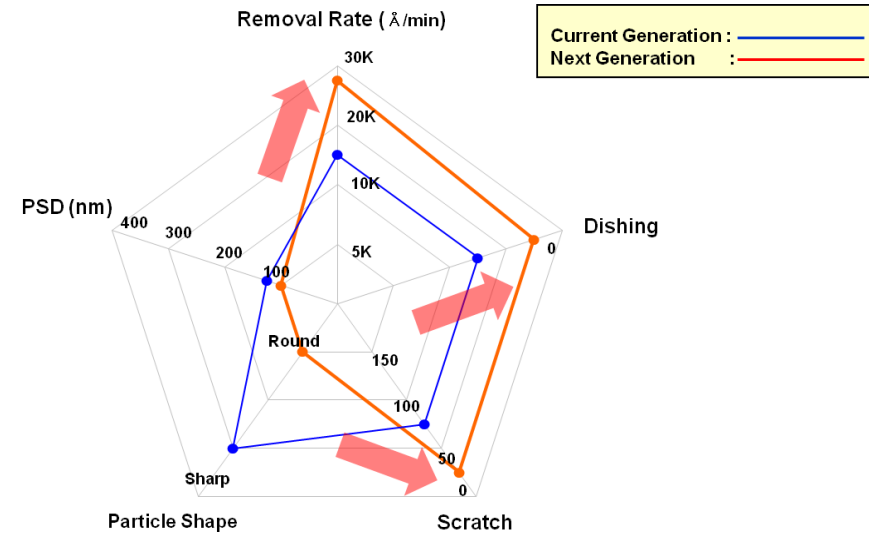
Abrasive

Type / Size / Morphology / Crystallinity
pH / Conductivity
Dispersant / Dispersion Method
Large particle control

Chemical

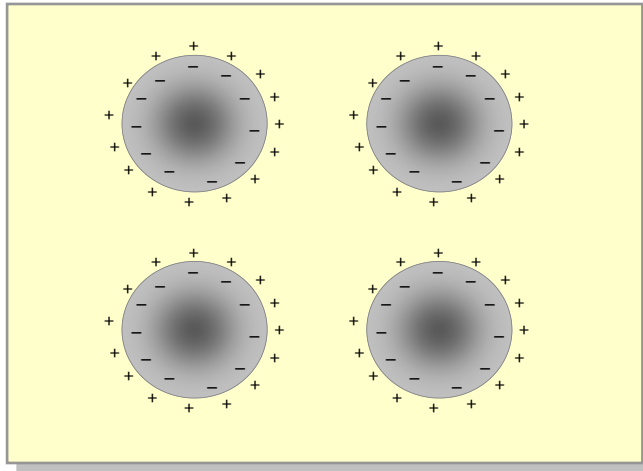
Surfactant / Functional group
Type & Mw. of Polymer
Hydrophilic & Hydrophobic
Titrant / pH / Conductivity

❖ Next Generation Ceria Slurry Challenges

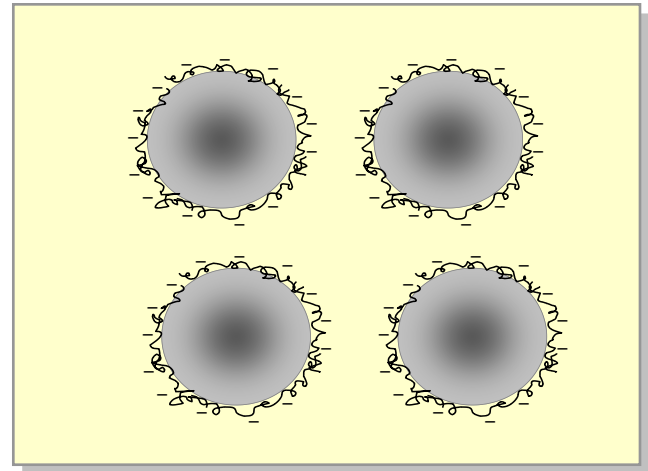


3. Colloidal Dispersion Stabilization

- ❖ **Electrostatic Stabilization**
 - : Electrostatic repulsive forces by charged surface
- ❖ **Steric Stabilization**
 - : Steric hinderance by adsorbed polymer
- ❖ **Electrosteric Stabilization**
 - : Electrostatic and steric



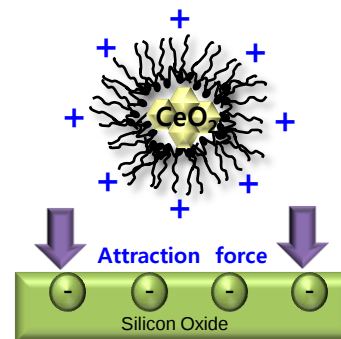
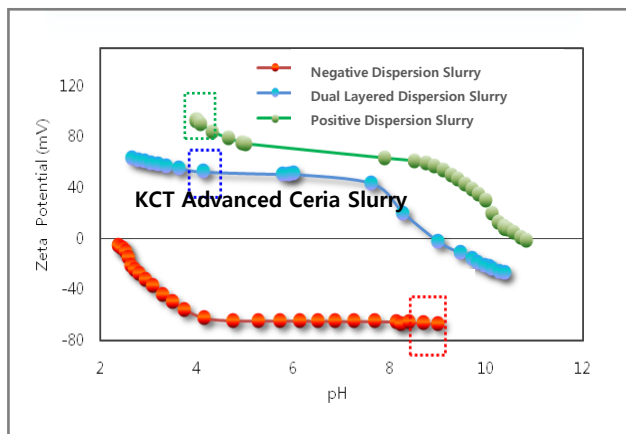
Electrostatic Stabilization



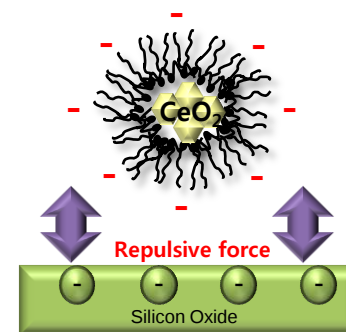
Steric Stabilization

4. Positive & Negative Dispersion Ceria Slurry

❖ Colloidal Ceria Slurry of Zeta Potential



Positive Dispersion



Negative Dispersion

Advantage of Positive Dispersion Ceria Slurry

- ① Excellent Oxide Removal Rate
- ② High Selectivity
- ③ Cost Down

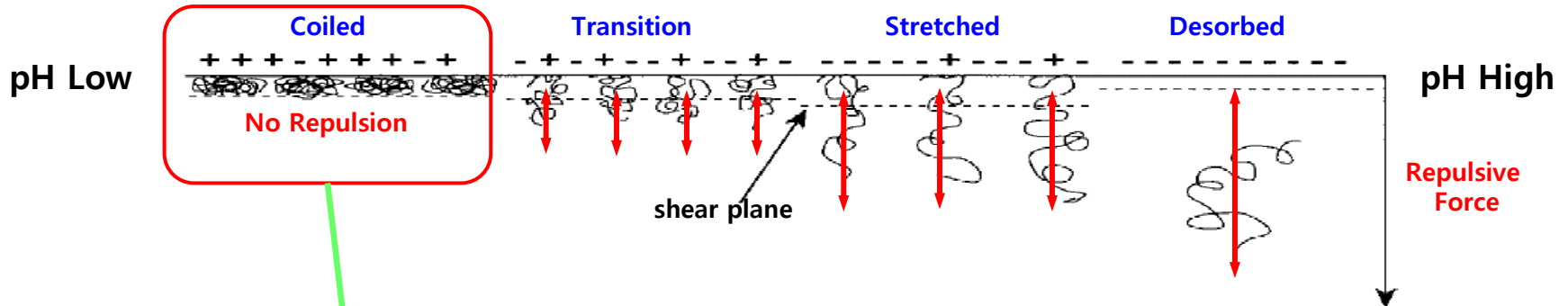
Disadvantage of Positive Dispersion Ceria Slurry

- ① Increasing the Defect Counts
- ② Yellow stain of Pad & Conditioner
- ③ Decreasing Life time of Pad & Conditioner

5-1. Concept & Mechanism

❖ Slurry Mechanism

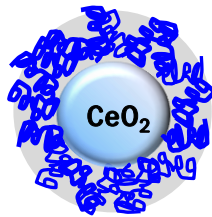
1) Polymer Behavior Control



2) Concept Modify Comparison

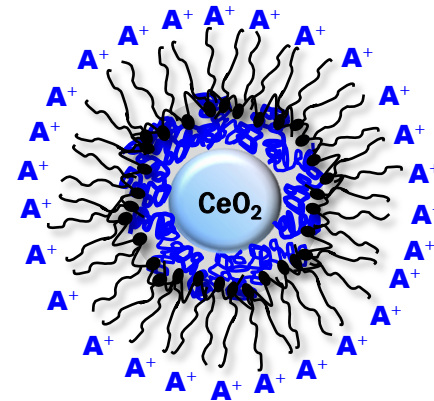
Steric Dispersion

Electrosteric Dispersion



1st Polymer Dispersion

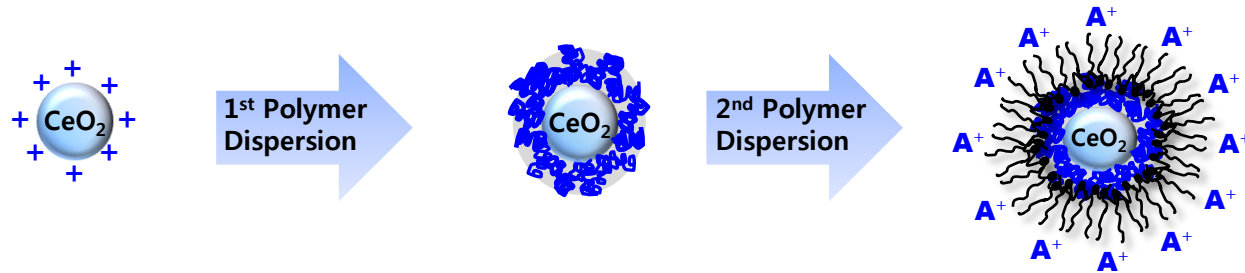
2nd Polymer Dispersion



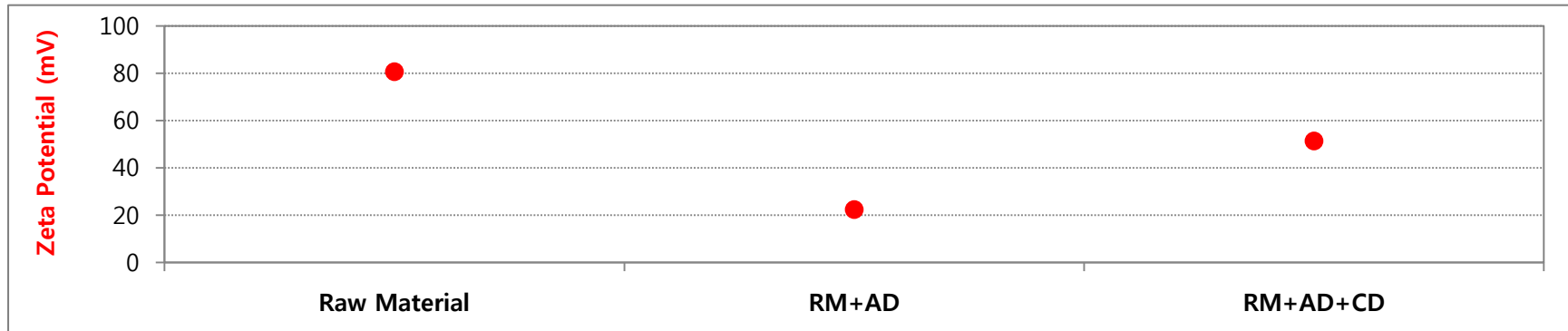
Dual Polymer Dispersion

5-2. Concept & Mechanism

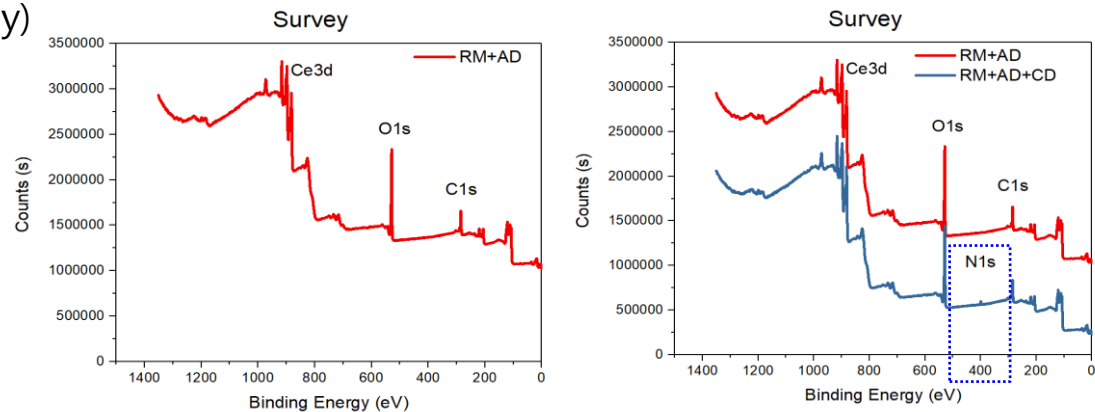
❖ Dispersion Process according to dispersion step



• Zeta Potential

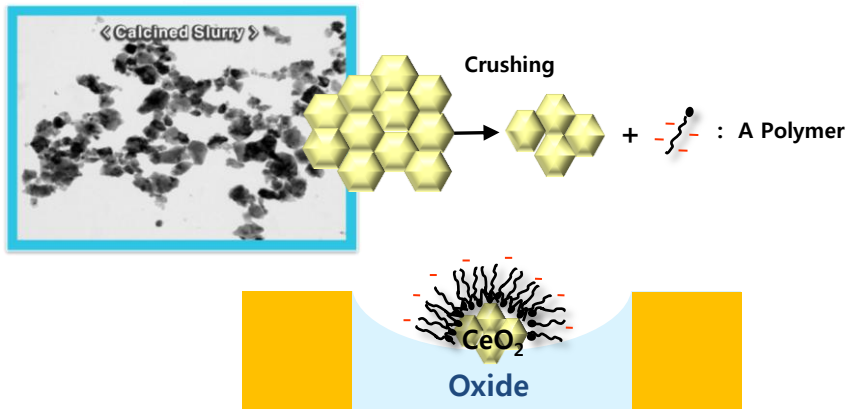


• XPS (X-ray photoelectron spectroscopy)

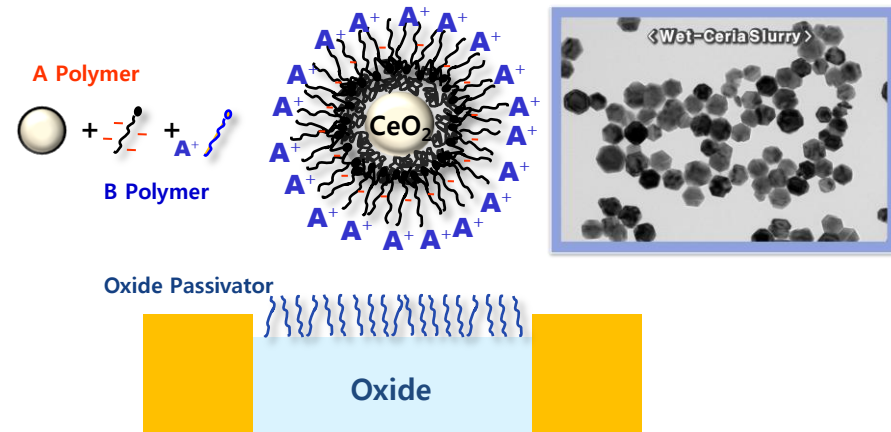


5-3. Concept & Mechanism

Conventional Calcined Ceria : Mono Layered Dispersant

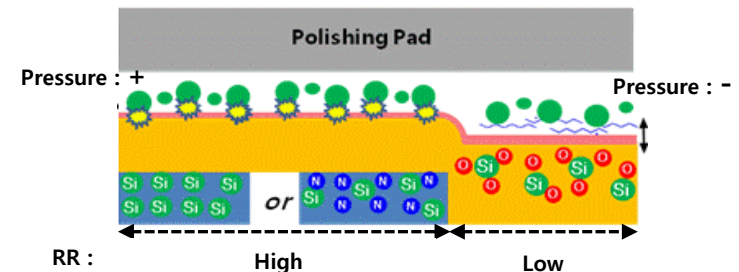
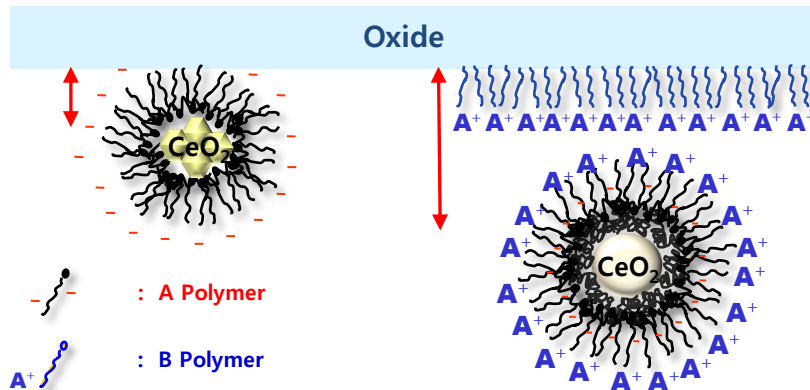


KCT Colloidal Ceria : Dual Layered Dispersant

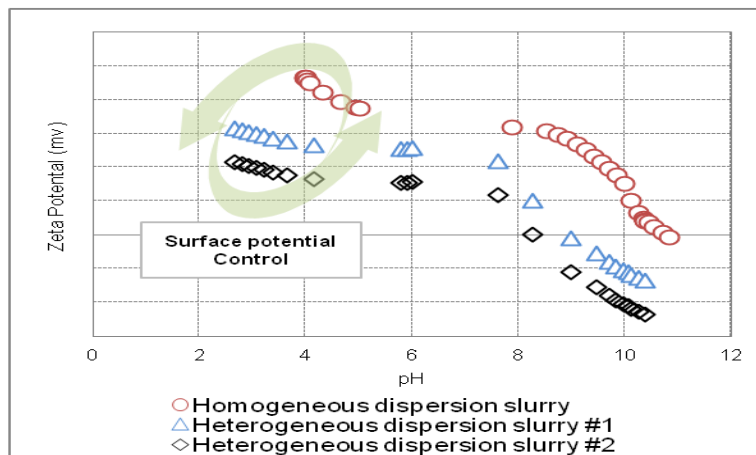


✓ Effect of Cushioning & Passivation

: Increasing of thickness of the polymeric layer and adsorption on the oxide film

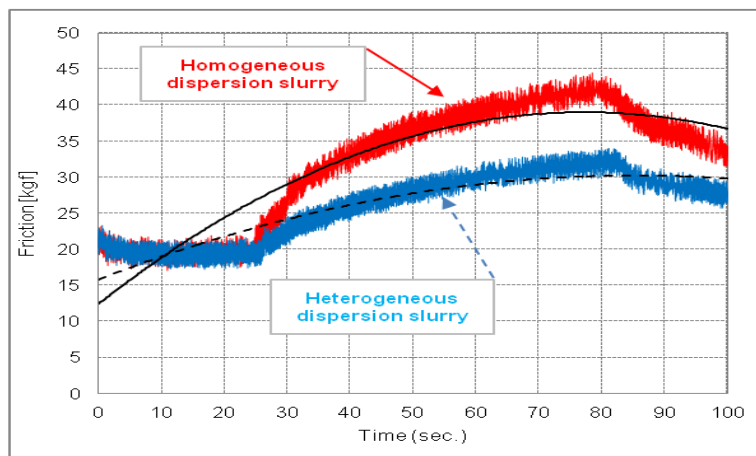


❖ Zeta potential evaluations with Homogeneous dispersion slurry and Heterogeneous dispersion slurry



- Zeta potential control by controlling the surface modification
- Maintaining a higher stability of dispersion
- ✂ We are expecting to have improvements in contamination of adsorption and cleaning problem after polishing .

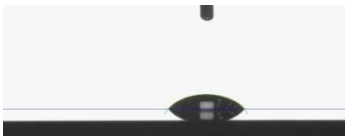
❖ Friction evaluations with Homogeneous dispersion slurry and Heterogeneous dispersion slurry



- Increase of buffer layer in particles
- Enhanced lubrication
- ✂ Decrease of frictional force on wafer

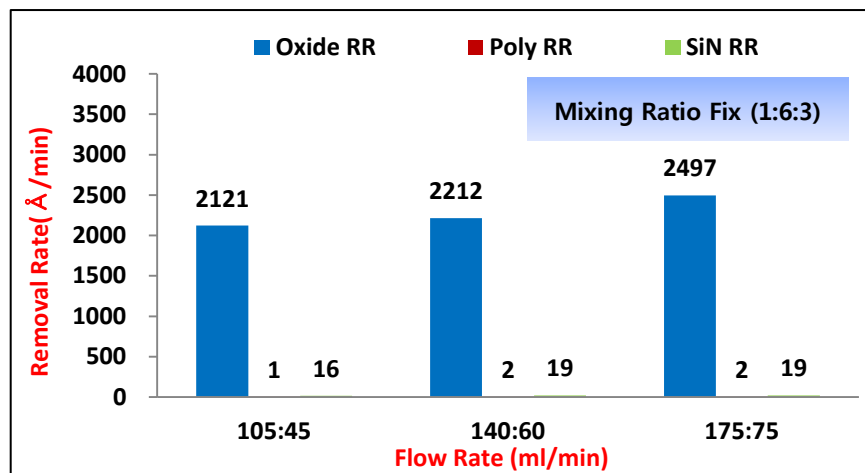
❖ Contact Angle

- Contact angle measurement according to slurry type.
- Positive Dispersion Slurry : Defect and contamination due to strong adsorption on oxide wafer.
- Slurry contact angle improved with dual layered dispersion.

측정	1st	2nd	3rd	Average
PRE (TEOS)				60.3°
	63.1°	58.7°	59.2°	
Negative Dispersion				60.0°
	59.5°	60.8°	59.7°	
Positive Dispersion				19.9°
	16.4°	24.1°	19.4°	
Dual Layered Dispersion				57.9°
	60.2°	55.8°	57.8°	

7-1. CMP Performance ; NPW

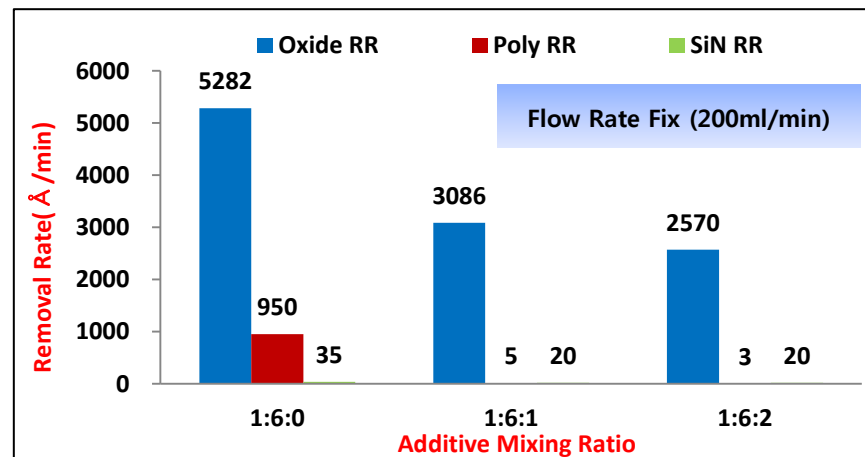
➤ Flow Rate Split Test



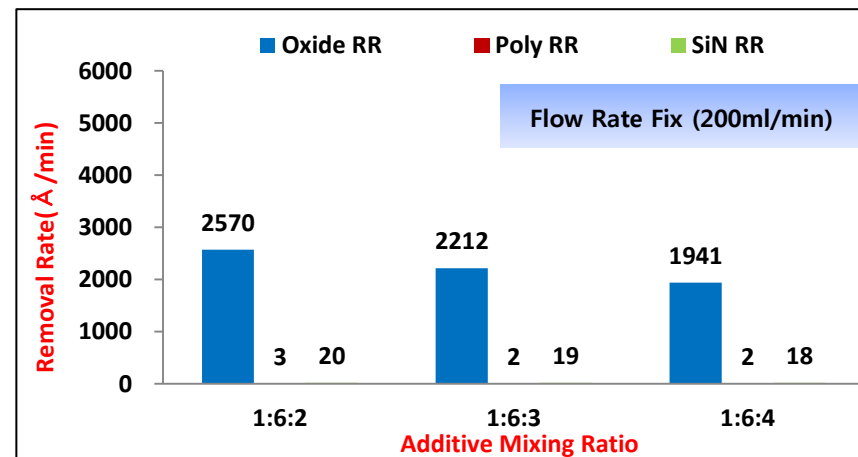
- The selectivity increases with the addition of additives.
- Oxide RR slowly increases with flow rate.
- Oxide RR decreases as additive mixing ratio increases.

CMP Condition		Remark
Machine	AP-300	CTS
PAD	IC 1000	Dow
Wafer Pressure	3.5psi	TEOS, Poly-si, SiN
Plate / Spindle Speed	93/87 rpm	

➤ Additive Mixing Ratio Split Test 1

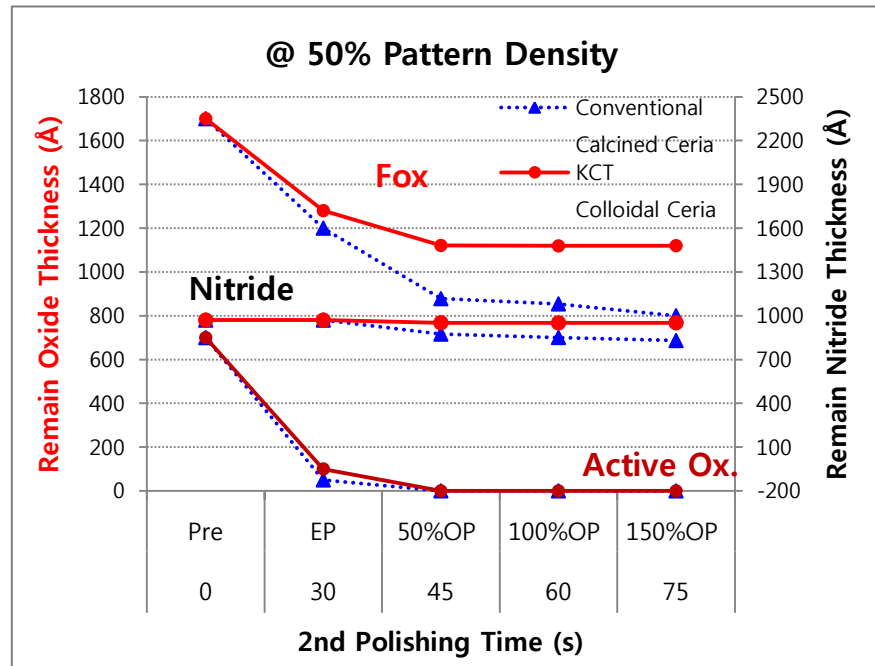


➤ Additive Mixing Ratio Split Test 2



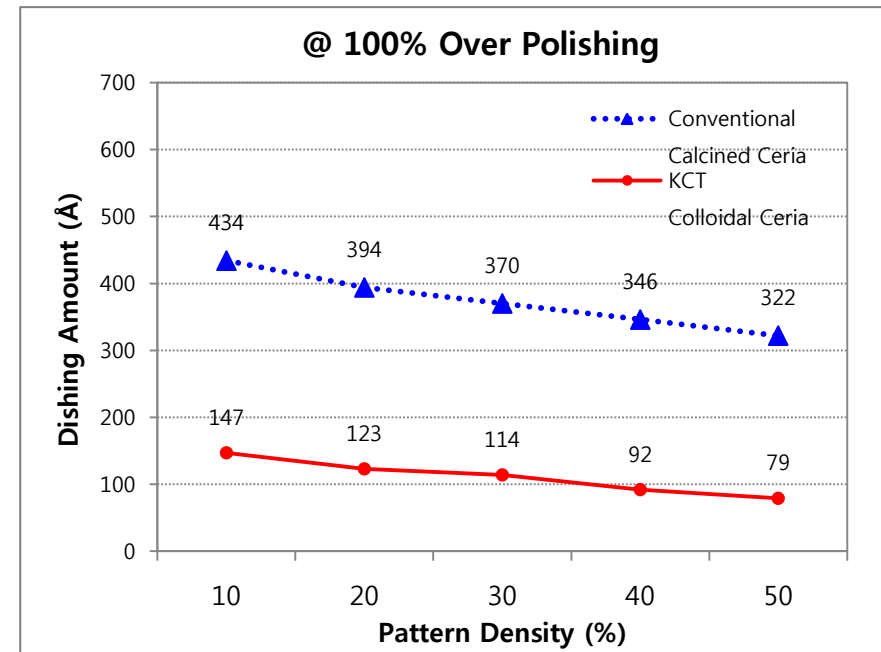
7-2. CMP Performance ; SoN Pattern

- Flat Profiles for Field Oxide and Nitride During Extended Over polish (OP)



- Field oxide Removal has been **improved up to 5 times** according to OP Time after EPD.
- At 50% OP, all of the active oxide was removed from the nitride surface.

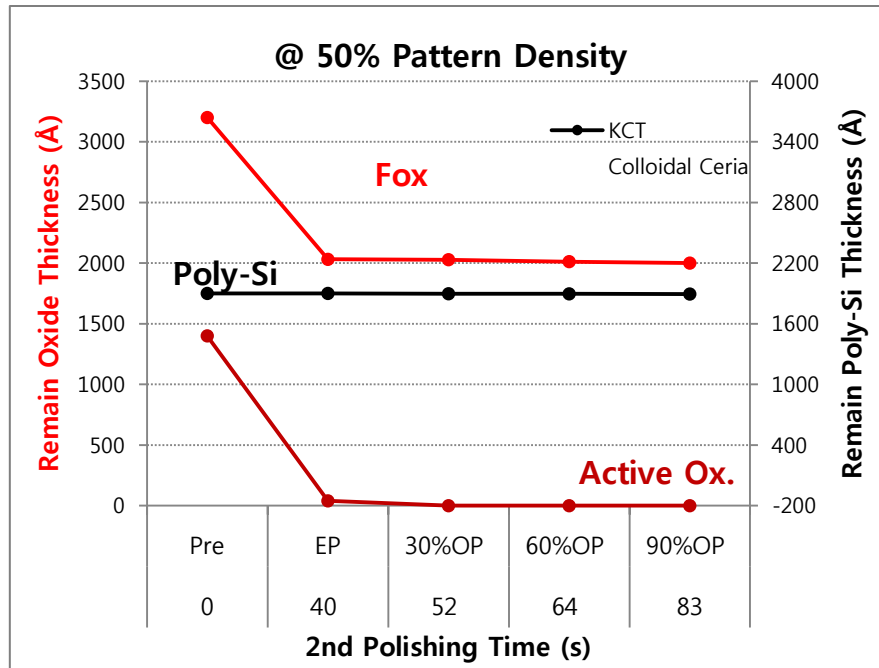
- Flat Profiles for Dishing During Extended Pattern Density



- As the pattern density increases, the dishing level decreases.
- Dishing level was improved by about **70%**.

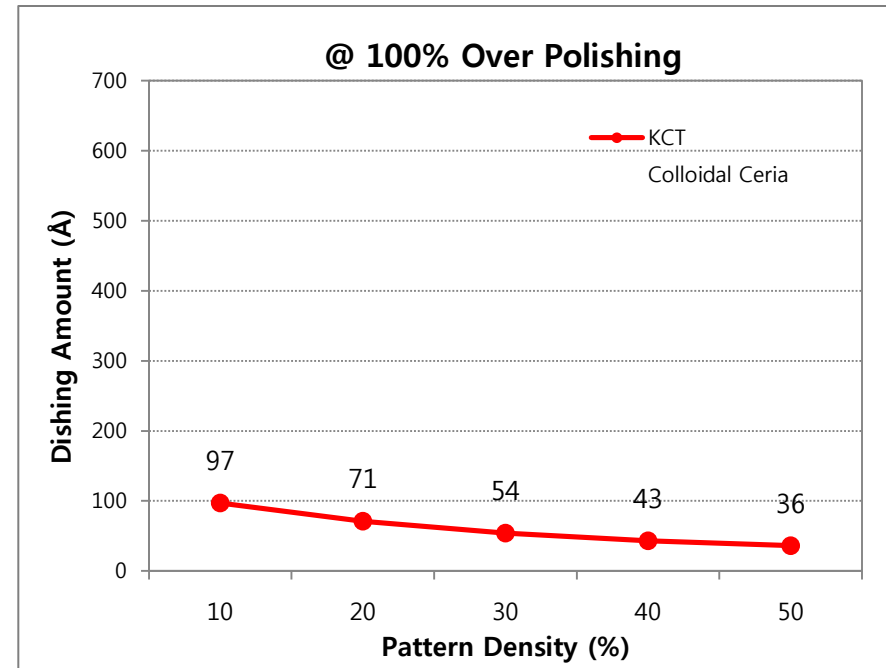
7-3. CMP Performance ; SoP Pattern

- Flat Profiles for Field Oxide and Nitride During Extended Over polish (OP)



- After EPD, it became a strong poly stop according to OP Time.
- All of the active oxide was removed on the Poly-Si surface.

- Flat Profiles for Dishing During Extended Pattern Density

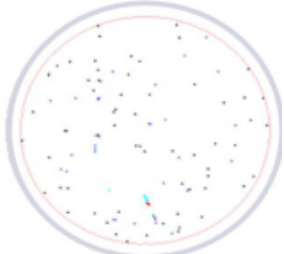
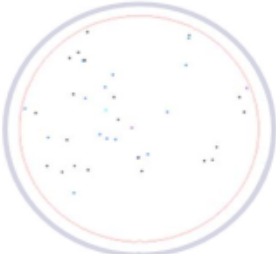


- As the pattern density increases, the dishing level decreases.
- The overall dishing level is very good.

7-4. CMP Performance ; Scratch

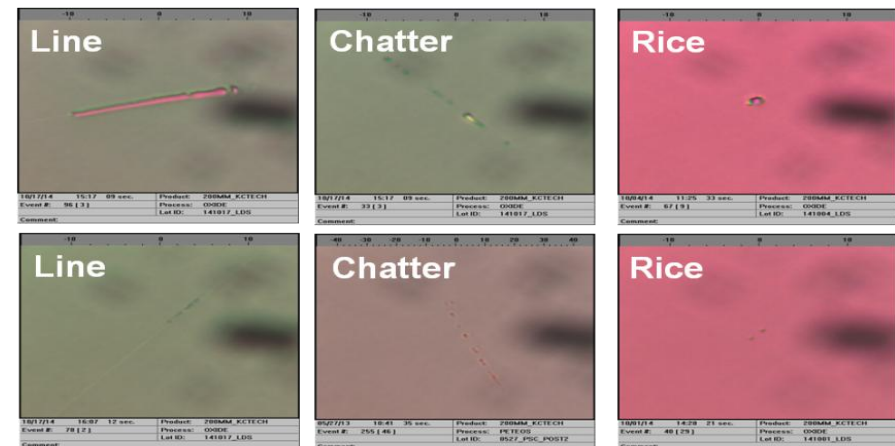
❖ Conventional calcined ceria slurry vs KCT Advanced colloidal ceria slurry

✓ Defect Evaluation

Defect Size \ Item	Conventional calcined Ceria Slurry	KCT Advanced Colloidal Ceria Slurry
0.16 ~ 0.2um	64	23
0.2 ~ 0.3um	27	16
0.3 ~ 0.5um	2	0
0.5 ~ 1.0um	3	0
1.0 ~ 5.0um	2	0
Total Count	108	42
Map		

✓ Scratch Review Evaluation

Slurry	Scratch			
	Total Defect	Line	Chatter	Rice
Conventional Calcined Ceria Slurry	108	4	3	2
KCT Colloidal Ceria Slurry	42	0	0	0



※ KCTech's colloidal ceria slurry has achieved **60% decreased** defect count and **Scratch free** in comparison to conventional calcined ceria slurry.

- KCTech' s Colloidal Ceria Slurry applied **Dual Layered Dispersion** technology.
- We have improved frictional force between particles and wafer by developing buffing layer and lubrication and **improved contamination from adsorption** and cleaning problem.
- We have achieved **High & Multi selectivity** on SiN, Poly Si by using proper chemical.
- Dishing level is below 100 Å at 50% Density pattern and **great dishing level** particularly on Low Density pattern.
- We have achieved 60% decreased defect count and **Scratch Free** in comparison to conventional calcined ceria slurry.

Thank You!