Shallow Trench Isolation CMP:
Slurry chemistry, Cleaning chemistry and mechanisms

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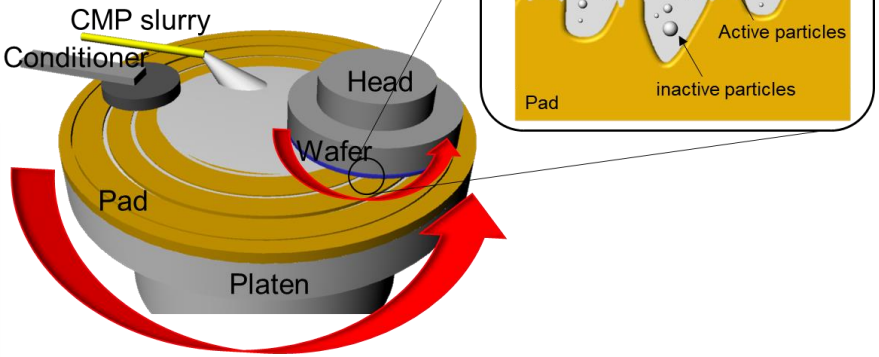
Clarkson™

Chemical Mechanical Planarization

CMP is only technique that can achieve nano-level local and global planarization across 300 mm wafer

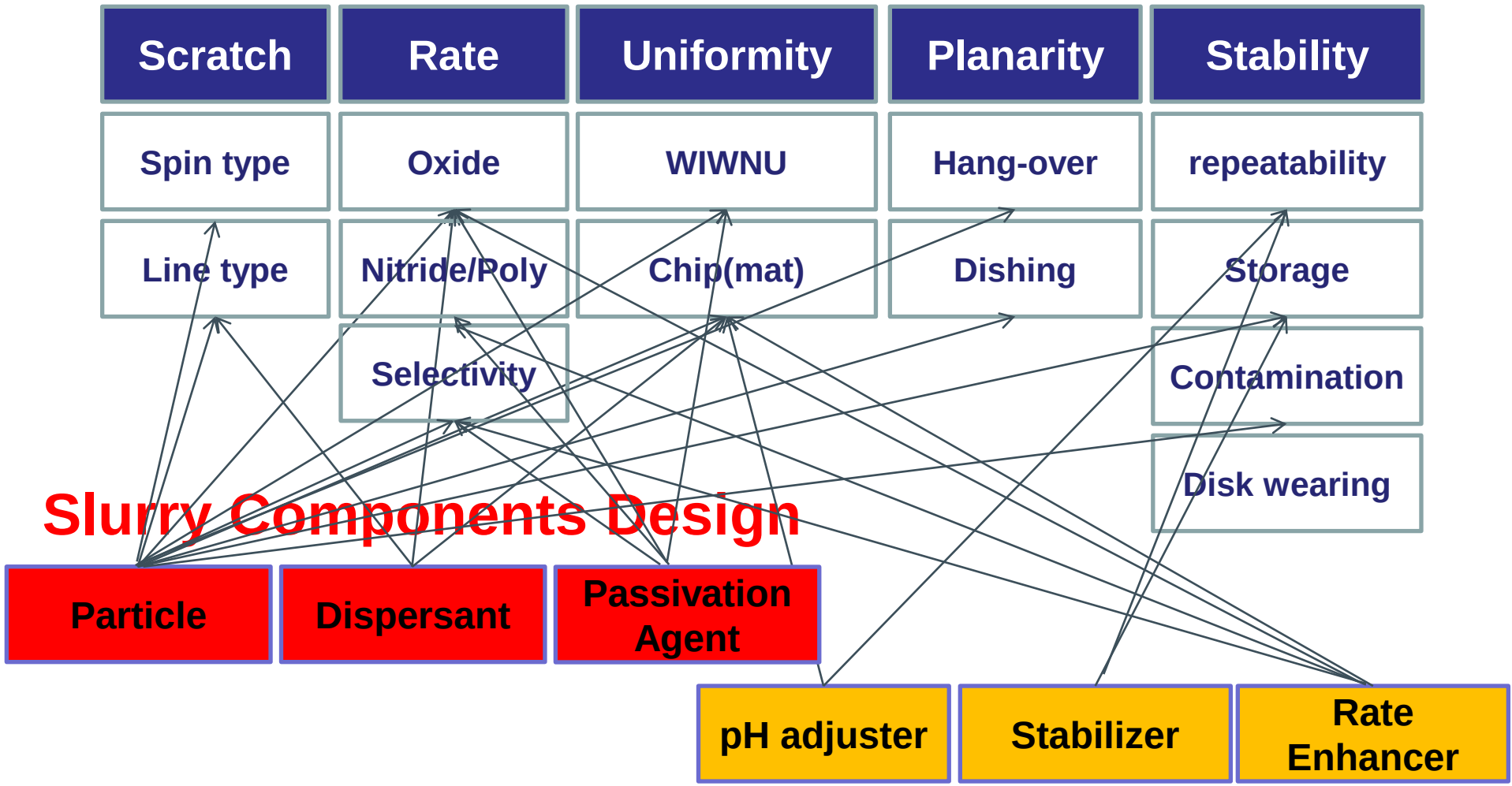


Significant Factors
- Slurry
- Pad
- Wafer
- Carrier
- Disk, Retainer Ring, etc..

CMP results
- Removal rate
- Selectivity
- Scratch & Defect (dishing, erosion)
- Contamination, Durability, etc..

J. Seo "A review on chemical and mechanical phenomena at the wafer interface during chemical mechanical planarization." Journal of Materials Research (2021): 1-23 (Review paper).
Images from TechInsights

The Effect of Slurry Components on STI CMP Performances

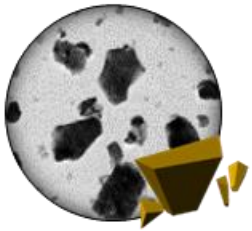


J. Seo et al., Preparation and characterization of slurry for CMP, in Advances in Chemical Mechanical Planarization (CMP), edited by S.V. Babu (2021)

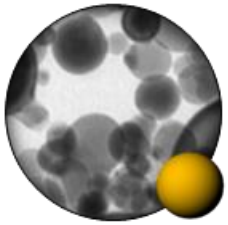
Abrasives for CMP-What is Next??

Calcined ceria particles

Typical shape



Ceria



Doped-ceria

Pre-treated ceria

Synthesis procedure

Precursor

- Precursors
- Pre-treatment

Particles

- Temperature, Time, Atmosphere

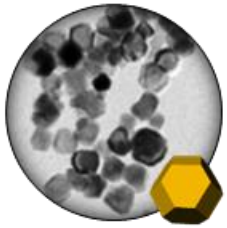
Formulating

- Milling types and conditions
- Types and size of Filtration
- Refinement treatment
- Chemical additives
- Mixing types and conditions

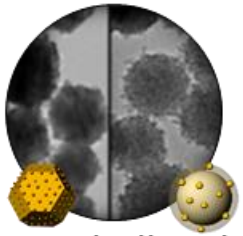
CMP Slurry

Colloidal ceria particles

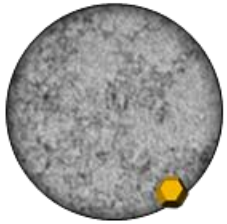
Typical shape



Ceria



Core shell ceria



Superfine ceria

Synthesis procedure

Precursor

- Precursors/ Precipitation agents
- Pre-treatment

Particles

- Solvent, pH, Temperature, Time
- Types of reactants and reactors
- Precursor's concentration and ratio

Formulating

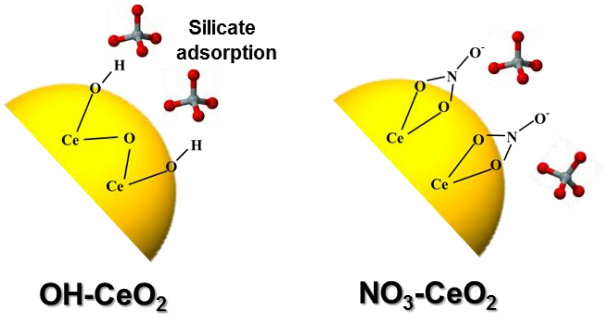
- Washing and decant
- Types and size of Filtration
- Drying conditions
- Chemical additives
- Mixing types and conditions

CMP Slurry

J. Seo et al., *ECS Journal of Solid State Science and Technology*, 2022, 11, 084003 (perspective article).

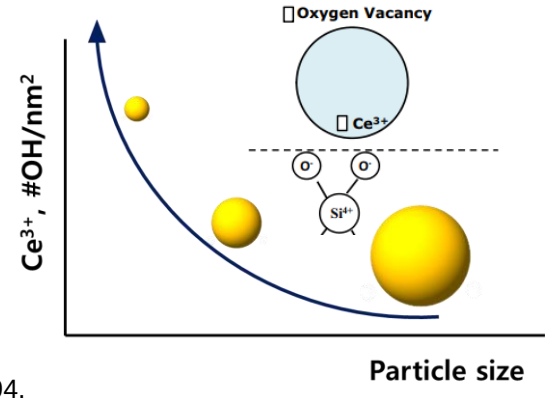
Our current research on CMP and Post CMP Cleaning

Processing pathway-dependent Surface chemistry



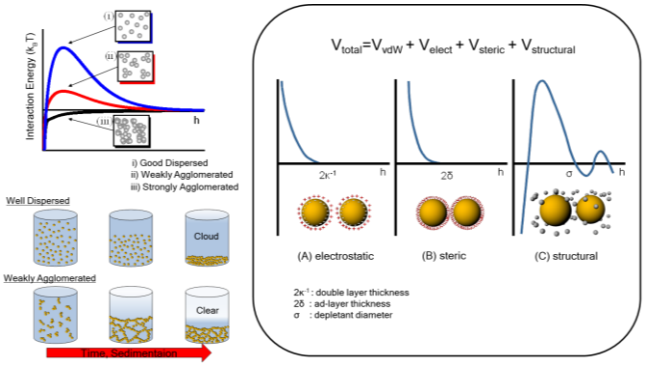
J. Seo,et al., *ACS Appl Mater Inter*, 2014, 6, 7388-7394.

Size-dependent Surface chemistry

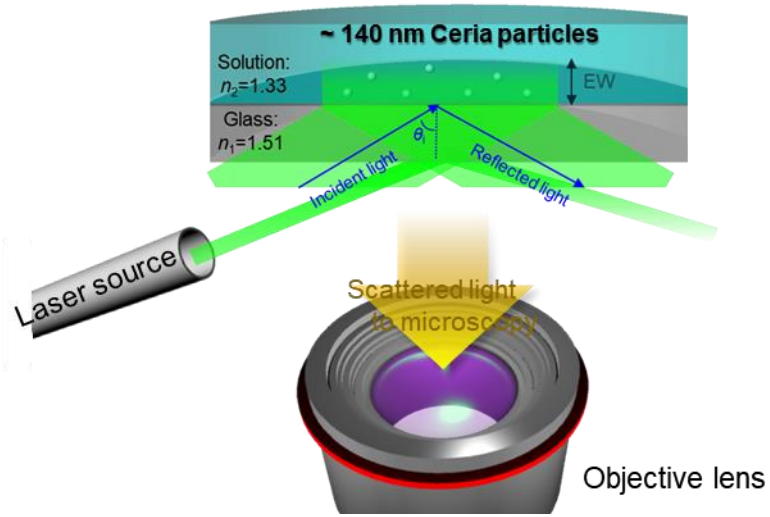


J. Seo,et al., *Appl Suf Sci*, 2016, 389, 311-315.

Slurry preparation and dispersion

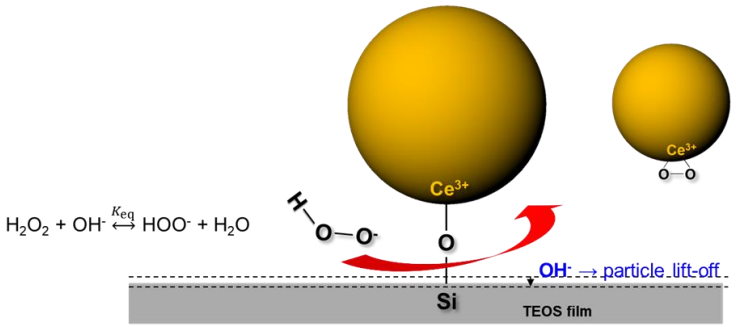


In-situ monitoring of the removal of particles



J. Seo,et al., *Journal of Materials Research,* 2021, 36(1), 258-267.
J. Seo,et al., *Journal of Materials Research,* 2020, 35(3), 321-331.

Post-CMP Cleaning



Bond type		Bond dissociation energy (kJ/mol)
Perhydroxyl anion (OOH)	O-O	210
	O-H	336
Hydroxyl ion	O-H	487
Ce-O-Si	Ce-O	790
	Si-O	452

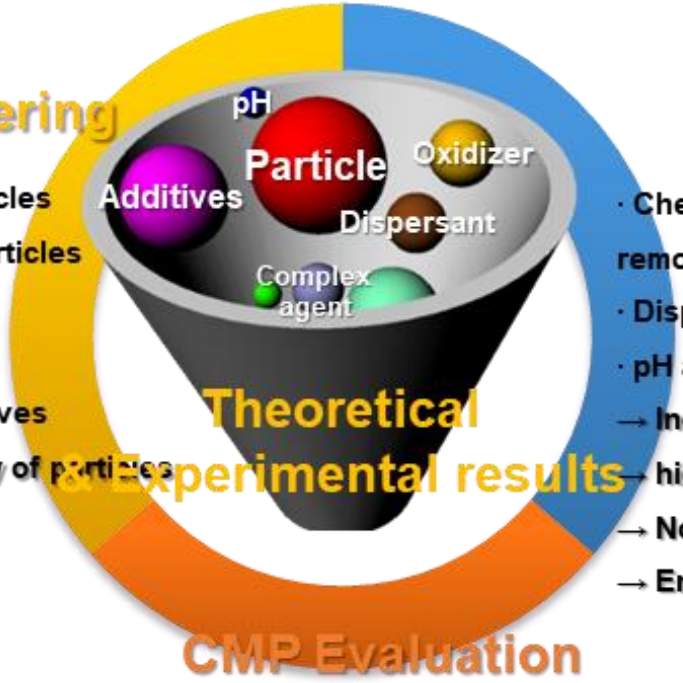
Table. Known binding energy data

J. Seo,et al.,*ECS J Sold State SC*, 2018, 7(50), P243-P252.
A. Gowda, J. Seo,et al.,*ECS J Sold State SC*, 2020, 9(4), 044013.

Strategies for next generation CMP slurries

Particle engineering

· Investigation and analysis of particles
· Smaller and spherical abrasive particles
· Core-Shell and doped particles
· Stabilization of surface reactivity
· Pre-treatment with chemical additives
→ Optimization of surface reactivity of particles



Chemical engineering

· Chemical agents for high polish rates and removal selectivity.
· Dispersants and surfactants
· pH adjusting agent, oxidizer, complexing agents
→ Increase in the affinity between particle and films
→ high selective removal of certain films
→ Non toxic chemical compositions
→ Environmentally friendly additives

CMP Evaluation

· Removal rate, Removal selectivity, Roughness.
· Surface roughness, low scratches and defects, low dishing
· Optimization of slurry
→ New slurry compositions for future devices

J. Seo "A review on chemical and mechanical phenomena at the wafer interface during chemical mechanical planarization." *Journal of Materials Research, 36, 235-57* (2021) (Review paper).

Seo's Collaborators and Sponsors

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