

Atomization of CMP Slurry and its Characterization

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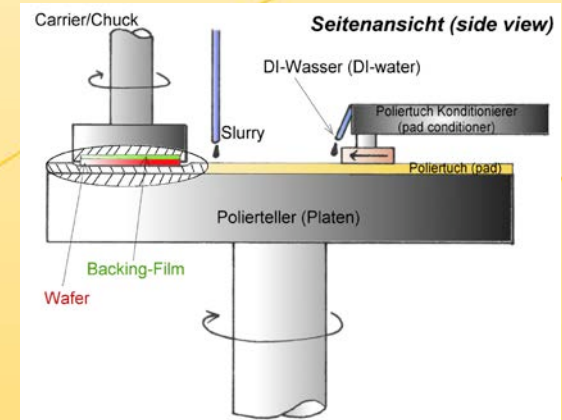
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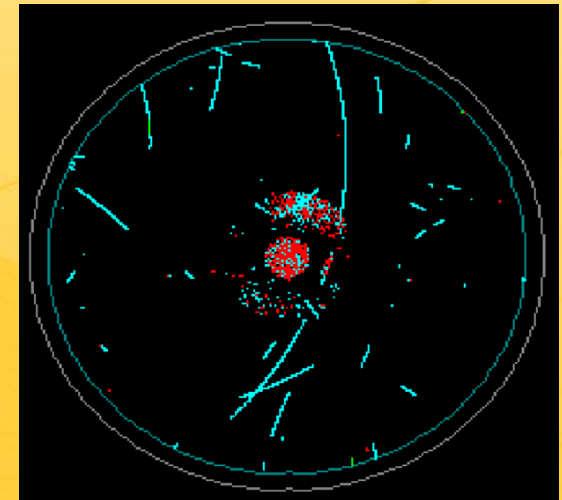
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Background

1. Chemical mechanical polishing (CMP) is a well known material processing technique used to polish silicon wafer surface. However, oversized or agglomerated CMP particles can cause micro-scratches on wafers.
2. Particle size analysis is therefore a key indicator of CMP slurry performance, and current CMP particles can be smaller than 10 nm, which is hard to be detected by typical liquid particle counters.
3. This study is to develop a CMP slurry particle sizing method, which can detect <10 nm cerium oxide particles in real time.



https://en.wikipedia.org/wiki/Chemical-mechanical_planarization



<http://www.vantagetechcorp.com/products/slurryscope>

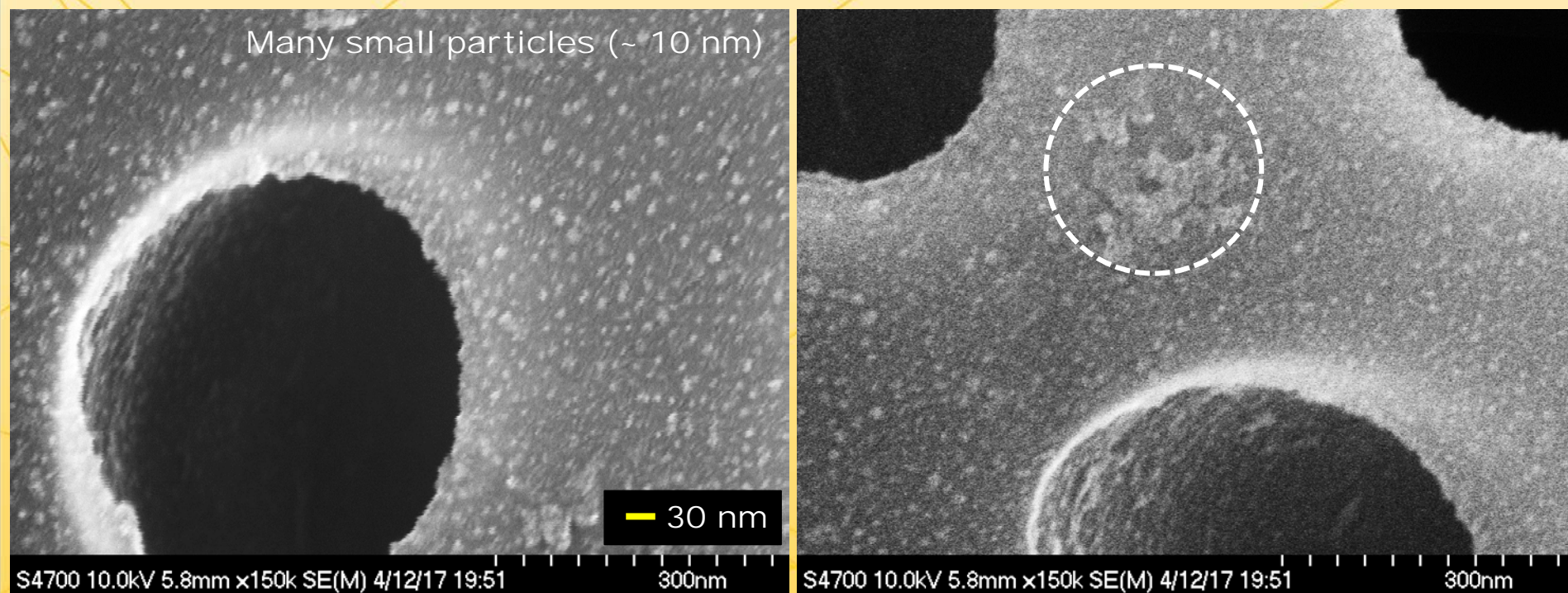


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SEM images of CMP particles



- CMP slurry particles on a 400 nm rated Nuclepore filter
- Small particles (~ 10 nm) and large aggregates are shown in SEM images.

Aerosolization methods



Atomizer



Scanning mobility particle sizer (SMPS)

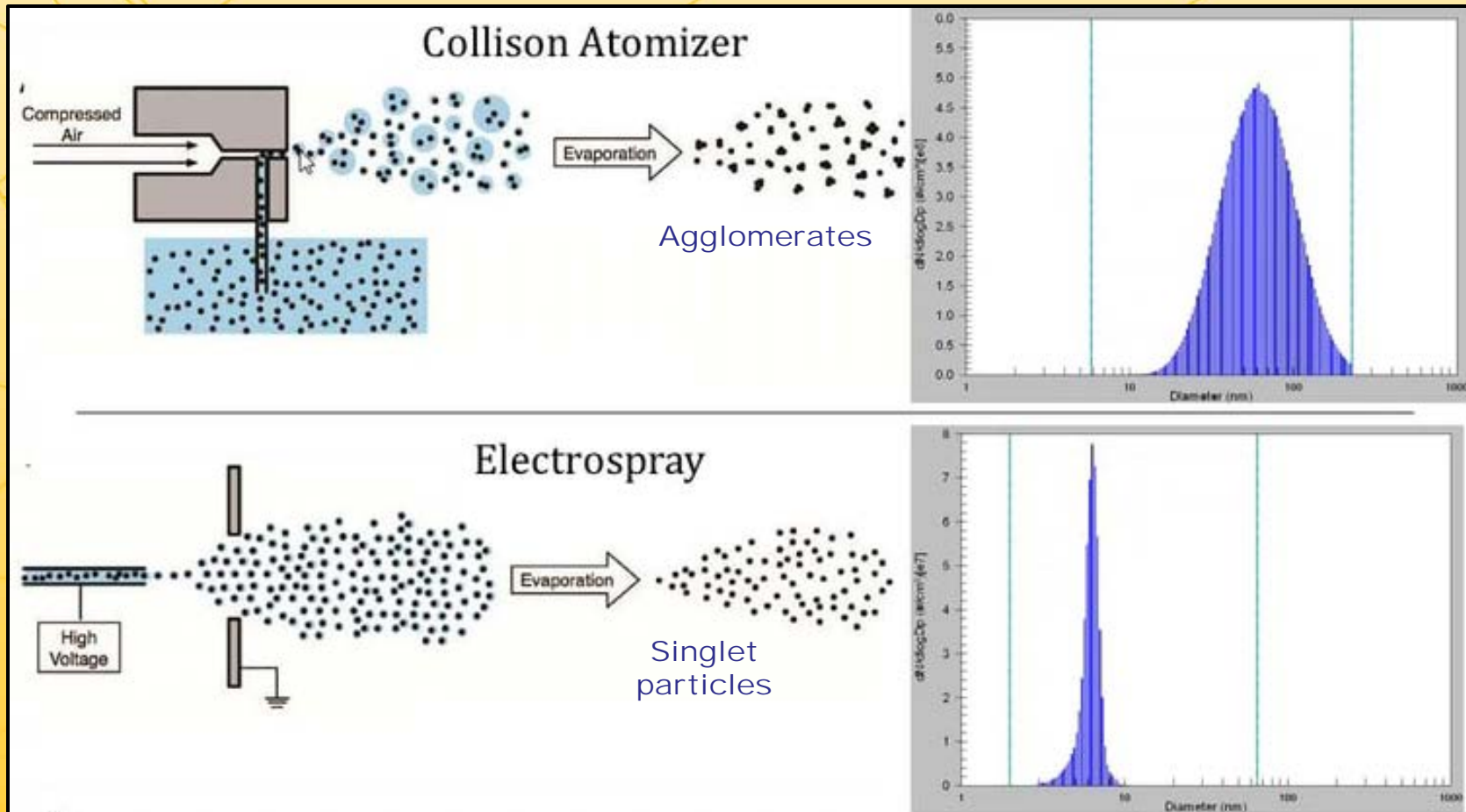


Electrospray

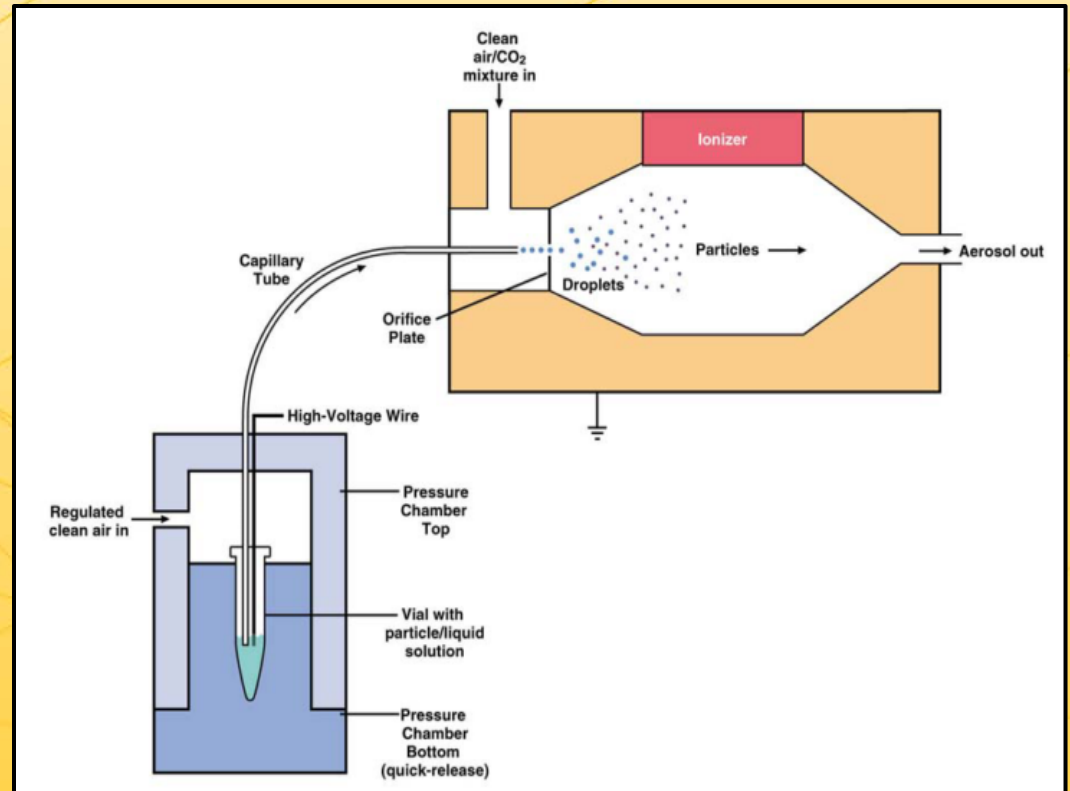


- Atomizer and electrospray are used for generating airborne particles.
- SMPS measures the size distribution of airborne particles (single particle counting).
- However, when using aerosolization method, residues contributed from water impurities and surfactant can interfere with the main particles.

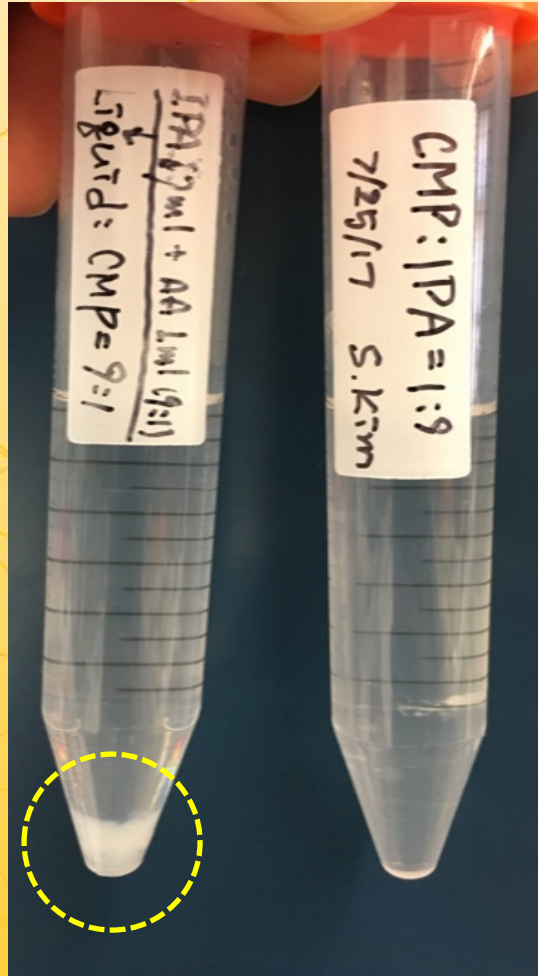
Atomizer vs. electrospray



Electrospray (TSI 3480)



CMP slurry particle agglomeration



CMP:(IPA 90% + A.A.* 10%)
= 1:9

CMP:IPA = 1:9

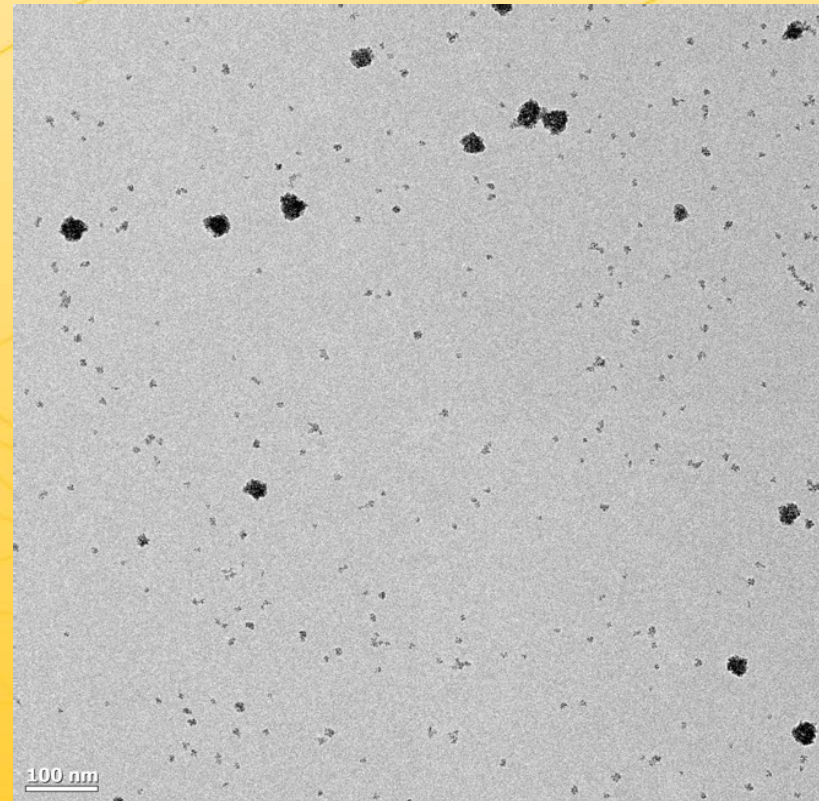
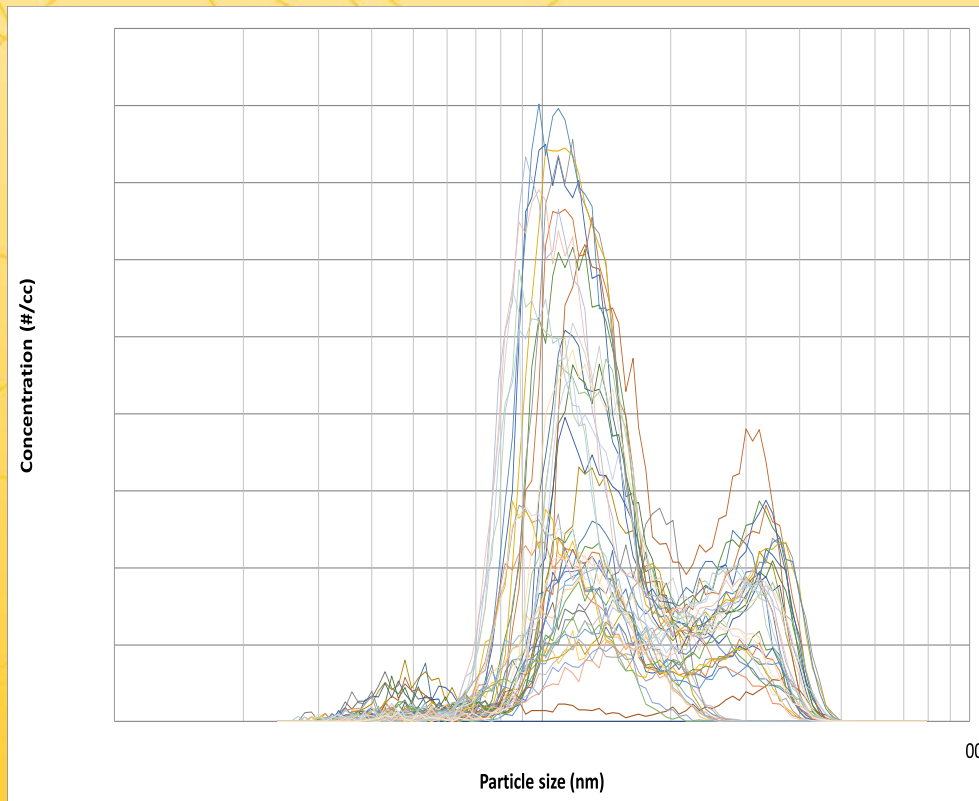
* In the previous tests, small amount of ammonium acetate was added to increase liquid conductivity for better electrospray.



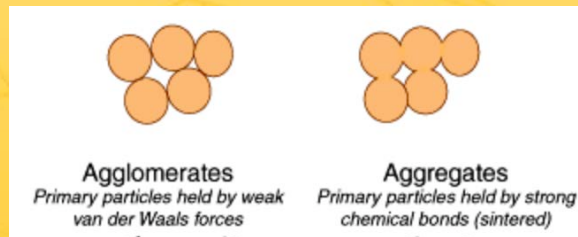
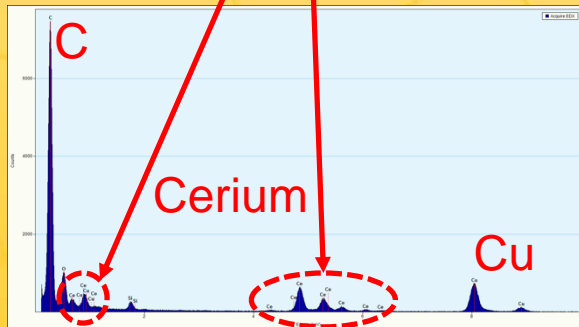
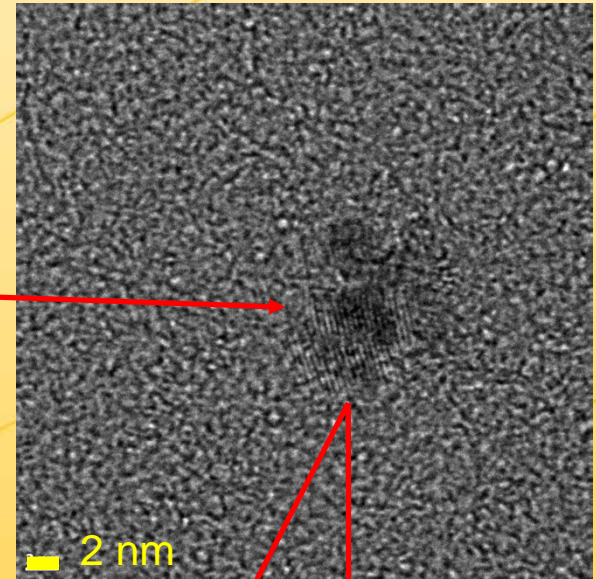
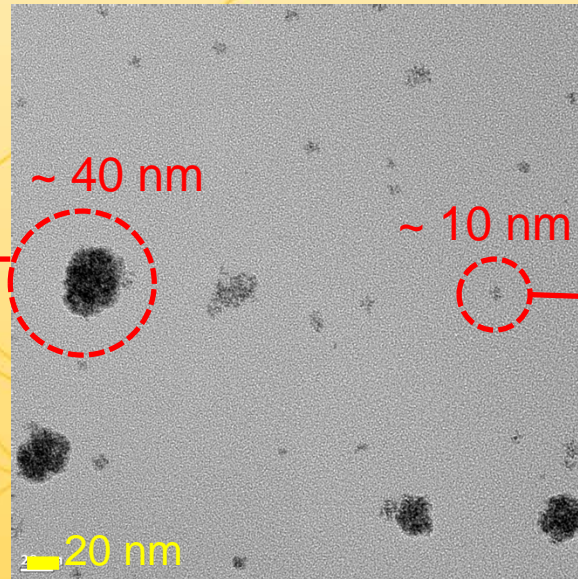
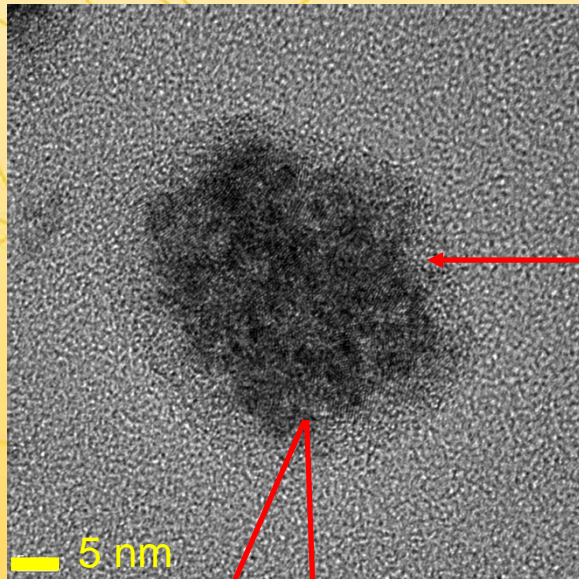
Electrospray result (x2 dilution)

CMP:IPA = 1:1 (10 min. ultrasonication)

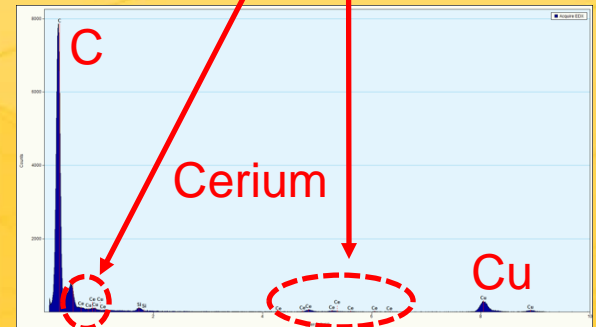
Electrospray (TSI 3480) with 100 μm capillary tube



TEM/EDS results (electrosprayed CMP slurry)



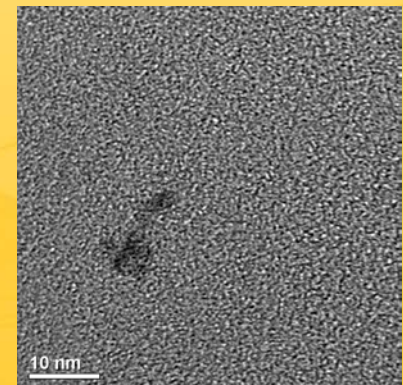
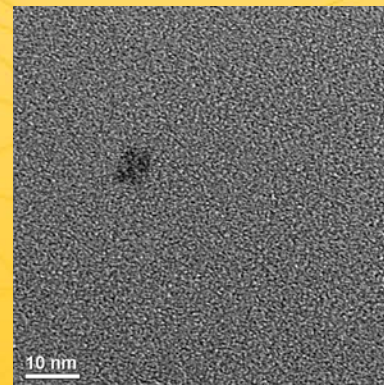
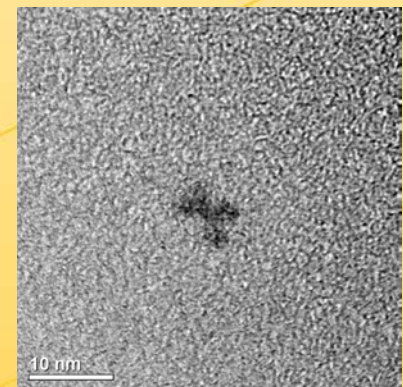
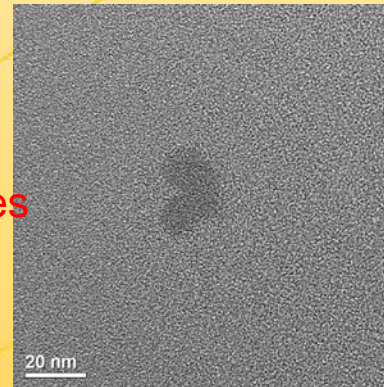
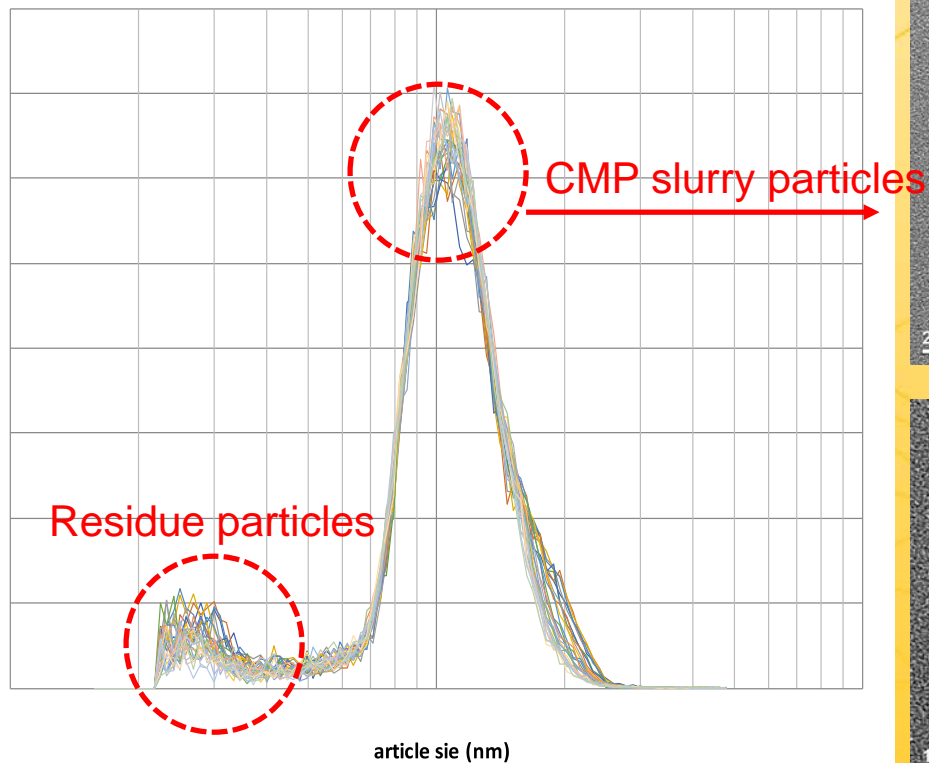
http://accesspharmacy.mhmedical.com/data/books/958/kla008_fig_28-06.png



Electrospray result (x100 dilution)

CMP: (IPA 50% + DI water 50%) = 1:99 (10 min. ultrasonication)

Electrospray (TSI 3480) with 40 μm capillary tube



Conclusions

- CMP slurry can be electrosprayed by 100 times diluting with mixture of IPA and DI water (1:1).
- After diluting CMP slurry, the particles can be easily agglomerated due to lower zeta potential, so it is required to break down the agglomerates using ultrasonication.
- The slurry particle peak is shown at 10 nm with electrospray, and more investigation is required to find out whether the peak is agglomerates or aggregates.

