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## behavior of ceria abrasives during CMP of optical glass

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# Presentation plan:

- Introduction
- Background on CMP parameters
- Objectives
- Our study
- Conclusion
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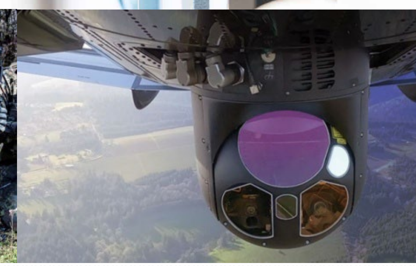
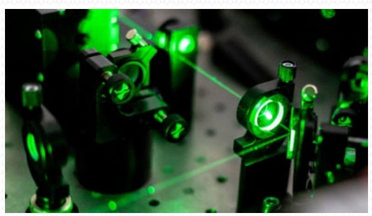
# Introduction

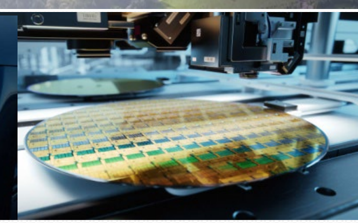


- Optical glass is essential for various indus
- **Photography and Imaging**
- **Optical Instruments**
- **Medical Devices**
- **Astronomy and Space Exploration**
- **Defense and Aerospace**
- **Laser Technology**
- **Semiconductor Manufacturing**
- **Automotive Industry**
- **Scientific Research…**








- CMP (chemical mechanical polishing)is a complex manufacturing process that combines chemical reactions with mechanical abrasion.

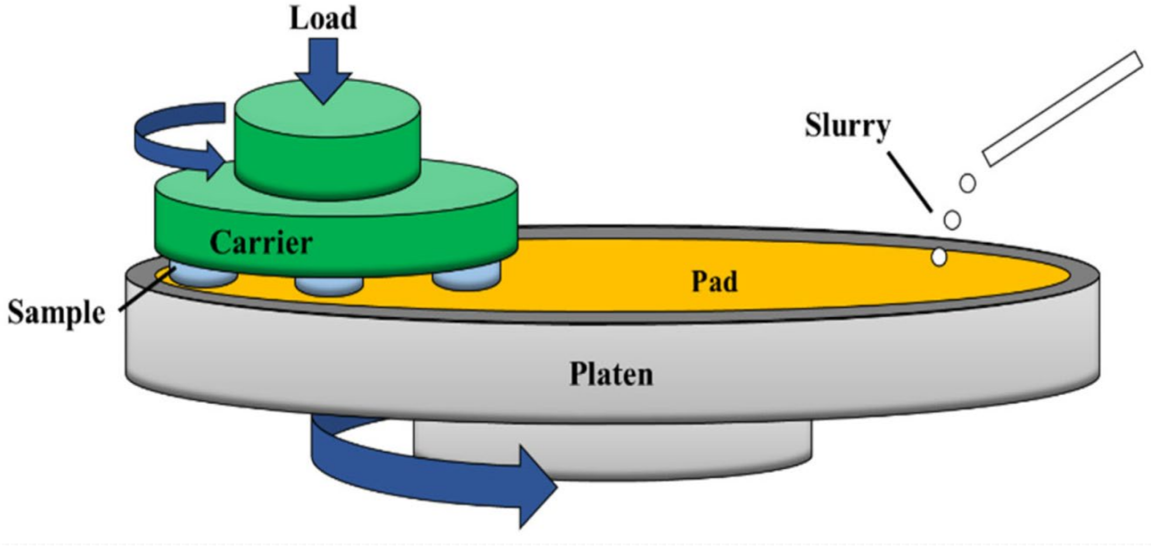
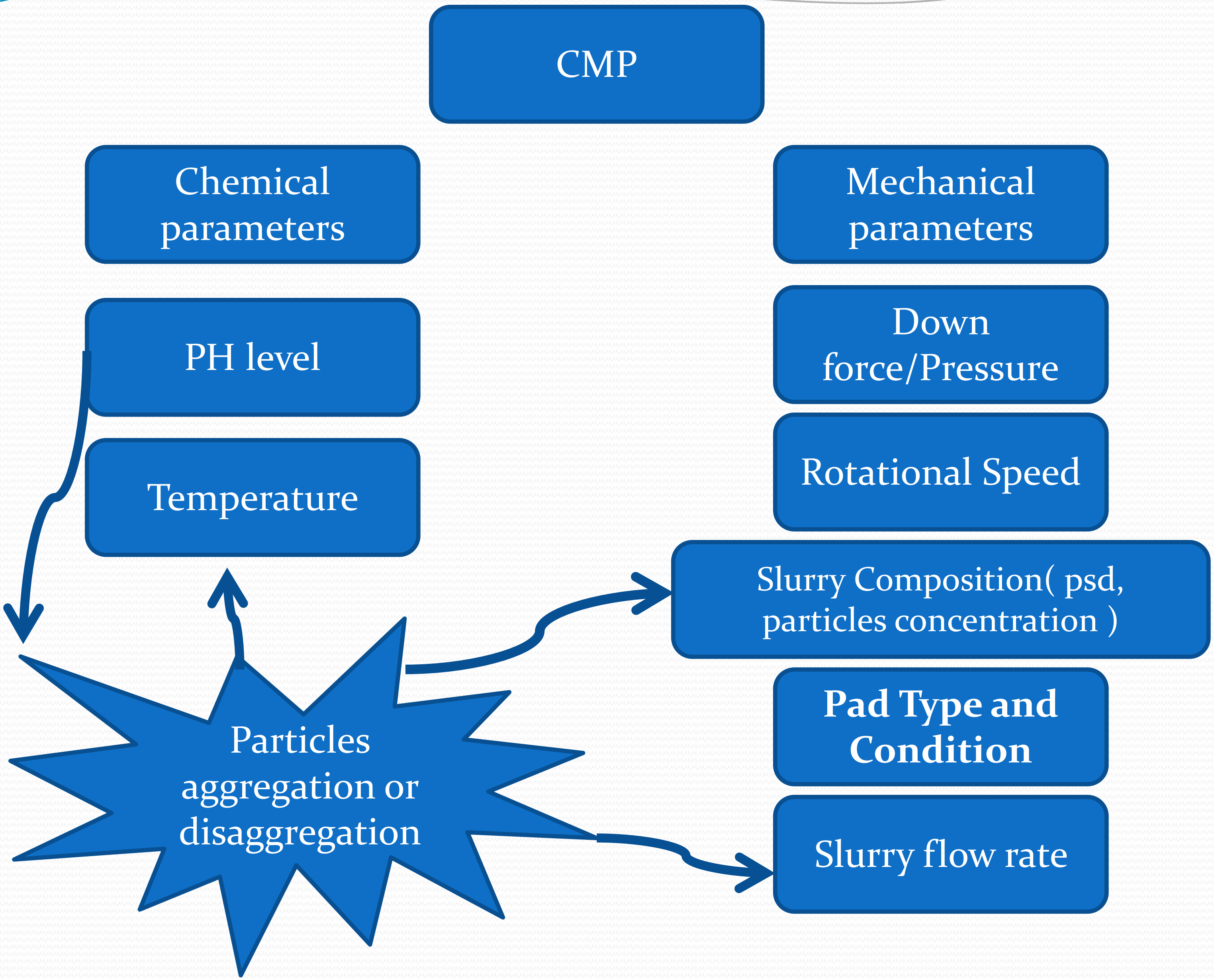



Figure 1: schematic illustration of  CMP polishing

# Background on CMP parameters



# Objectives

- To investigate the impact of glass chemical composition on ceria slurry particle size distribution while assessing related factors, including changes in PH and slurry stability(zeta potential ).

- This study aims also to contribute to a better understanding of how glass composition can affect the properties of ceria slurries with potential implication for optimizing glass polishing procedures.

# OUR STUDY

| | |
|---|---|
| **Work pieces** | Soda lime , fused silica and borosilicate glasses (7x7 cm) |
| Slurry | • ceria powder of average ⌀ ≈400 nm diluted in DI water<br>•Nano ceri type PB from pieplow and Brandt company |
| Polishing pad | LP-66 polyurethane pad |
| Polishing pressure | 12.2 kpa |
| Platen velocity | 150 $min^{-1}$ |
| Slurry flow rate | 12ml/min |
| Slurry concentration wt% | 3% |

Table 1 : polishing parameters and conditions

| Element-oxide | $SiO_2$ | $Na_2O$ | MgO | $Al_2O_3$ | $B_2O_3$ | $K_2O$ | CaO | $TiO_2$ | $Cr_2O_3$ | MnO | $Fe_2O_3$ | $ZrO_2$ | $SO_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soda lime w% | 72.80 | 13.07 | 4.21 | 0.48 | | 0.28 | 8.80 | 0.018 | 0.001 | 0.01 | 0.066 | 0.003 | |
| Borosilicate wt% | 75 | 8 | | 1 | 14 | | 2 | | | | | | |
| Fused silica wt% | 99.9 | | | | | | | | | | | | |

TABLE 2 : chemical composition of the polished glasses

# PH measurements

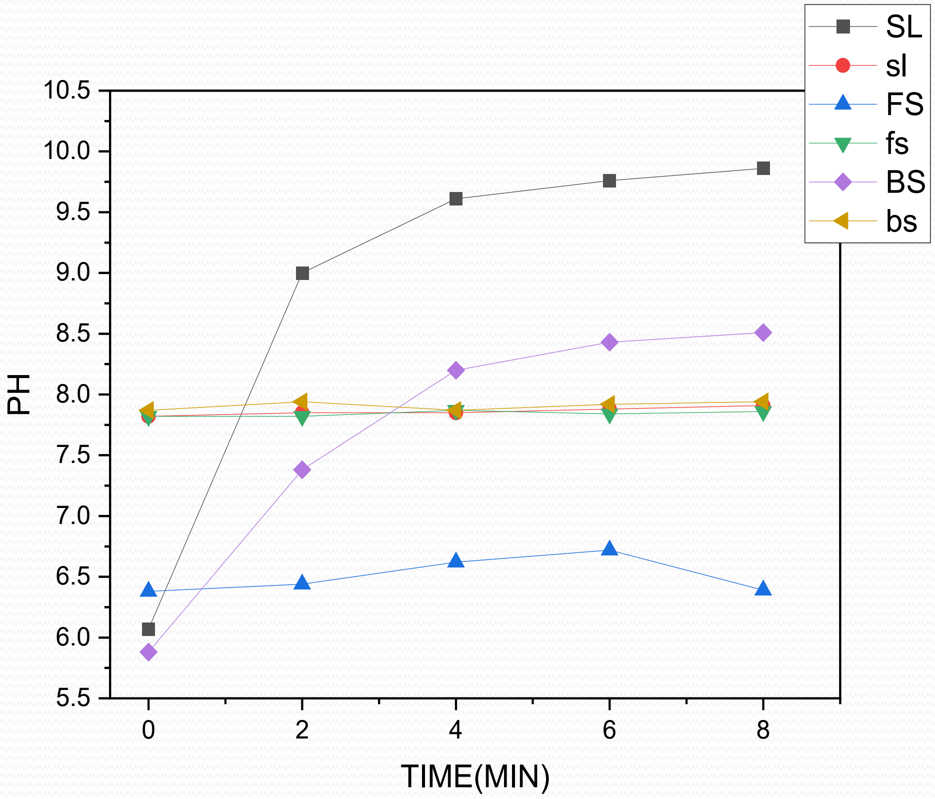



Fig 3. slurry ph measurements after each 2min polishing time.

| Slurry | particles |
|---|---|
| SL | big particles after polishing sodalime glass |
| sl | small particles after polishing sodalime glass |
| FS | big particles after polishing fused silica glass |
| fs | small particles after polishing fused silica glass |
| BS | big particles after polishing borosilicate glass |
| bs | small particles after polishing borosilicate glass |

Table 3: slurries measured during polishing

# Material removal and surface roughness

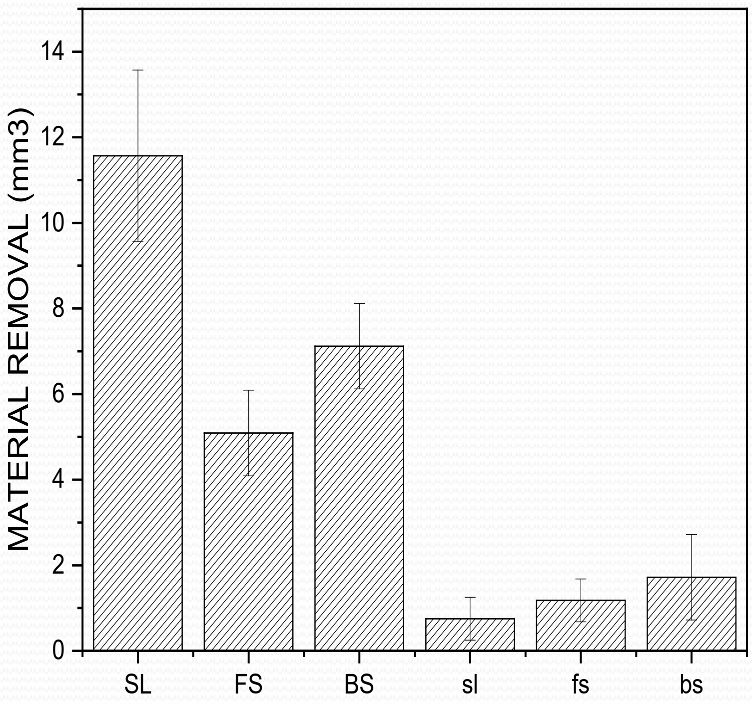



FIGURE 4:. Material removal after 8min polishing with Big ceria particles (SL,FS,BS) and small ceria particles (sl,fs,bs)

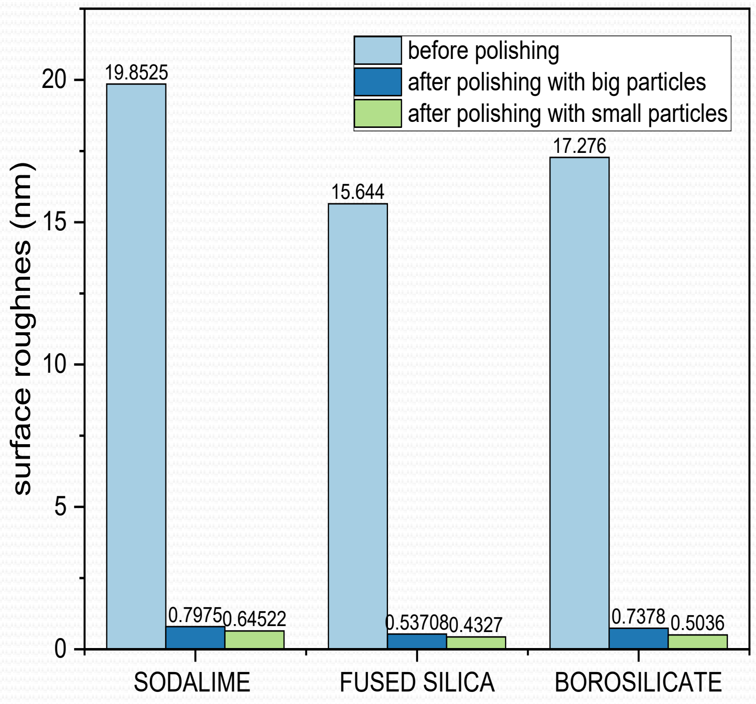



FIGURE 5:.surface roughens of glasses before and after polishing with the big and small ceria particles

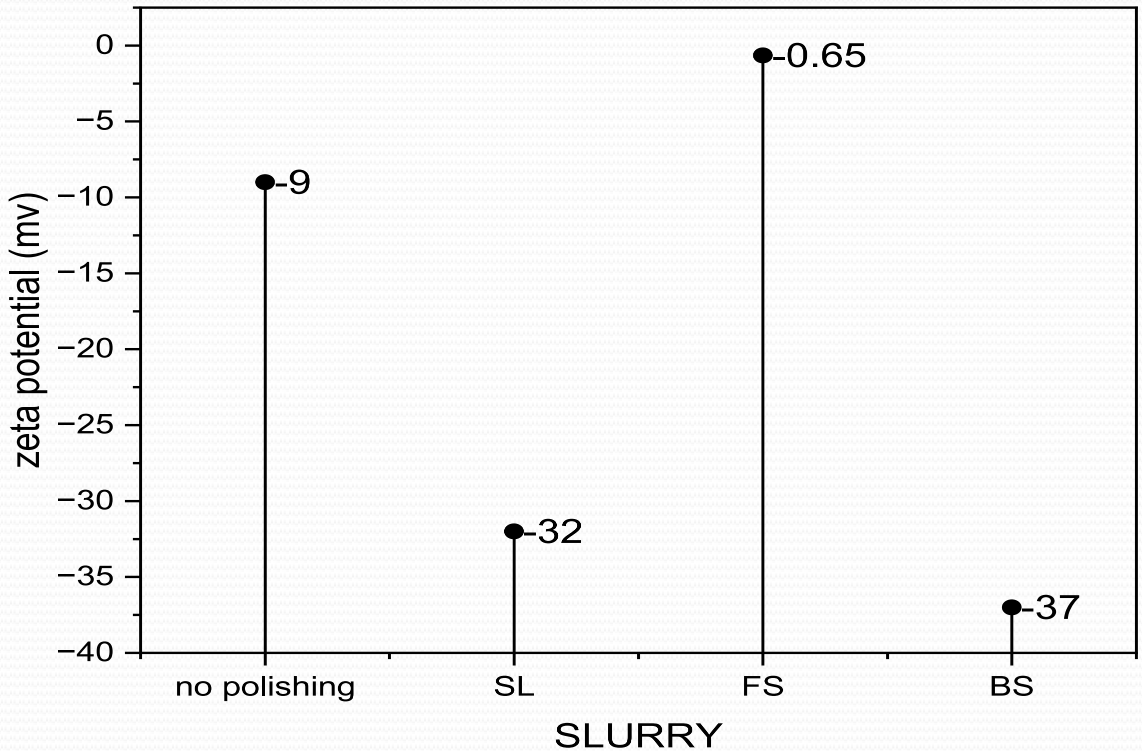



FIGURE 6:.Zeta potential measurements of big ceria particles before and after glasses polishing

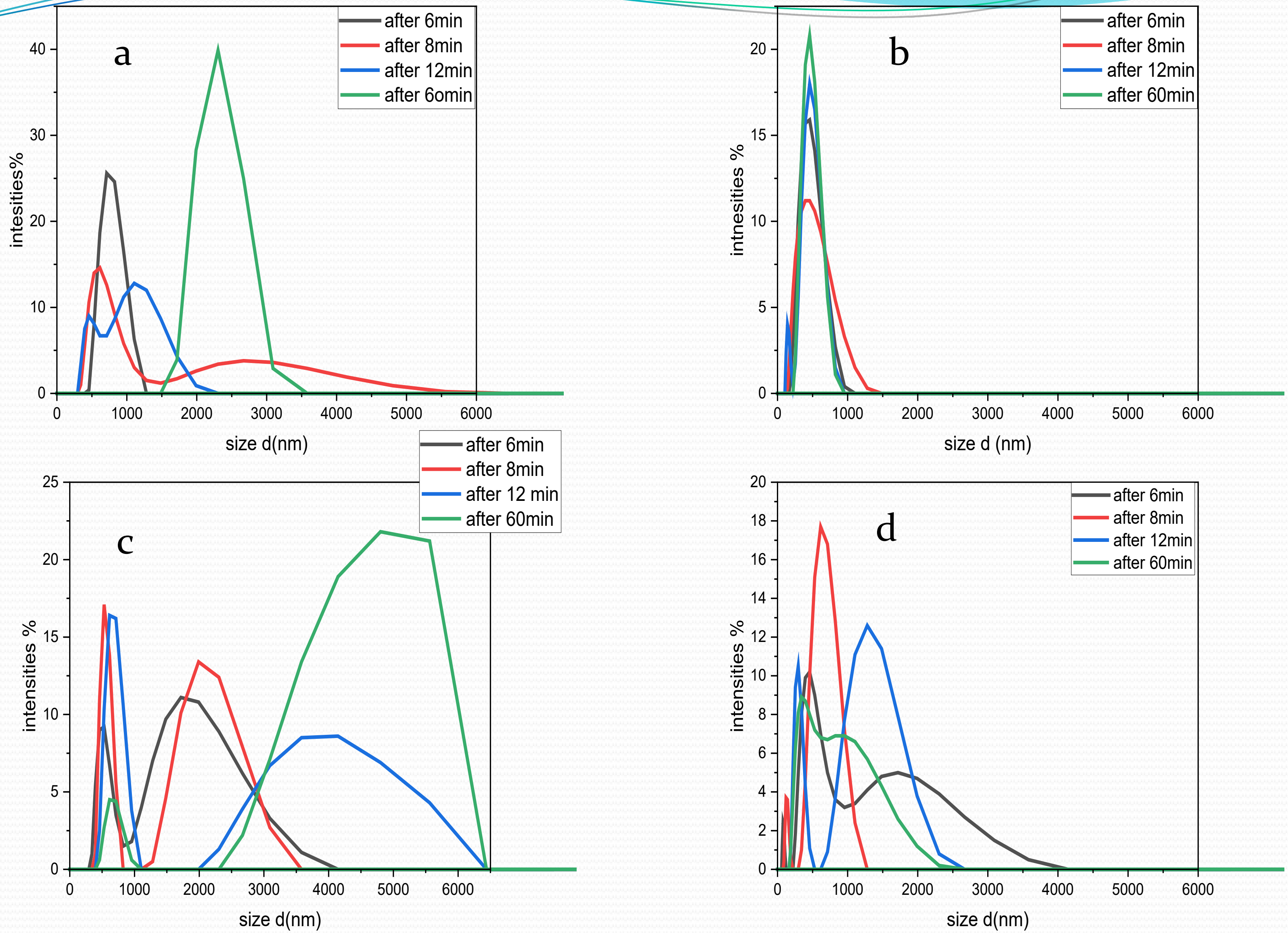



FIGURE 7. particles size distribution of big ceria particles (a) without glass polishing (b)after borosilicate glass polishing (c )after fused silica glass polishing (d) after soda lime glass polishing . Measured after ultrasonic dispersion

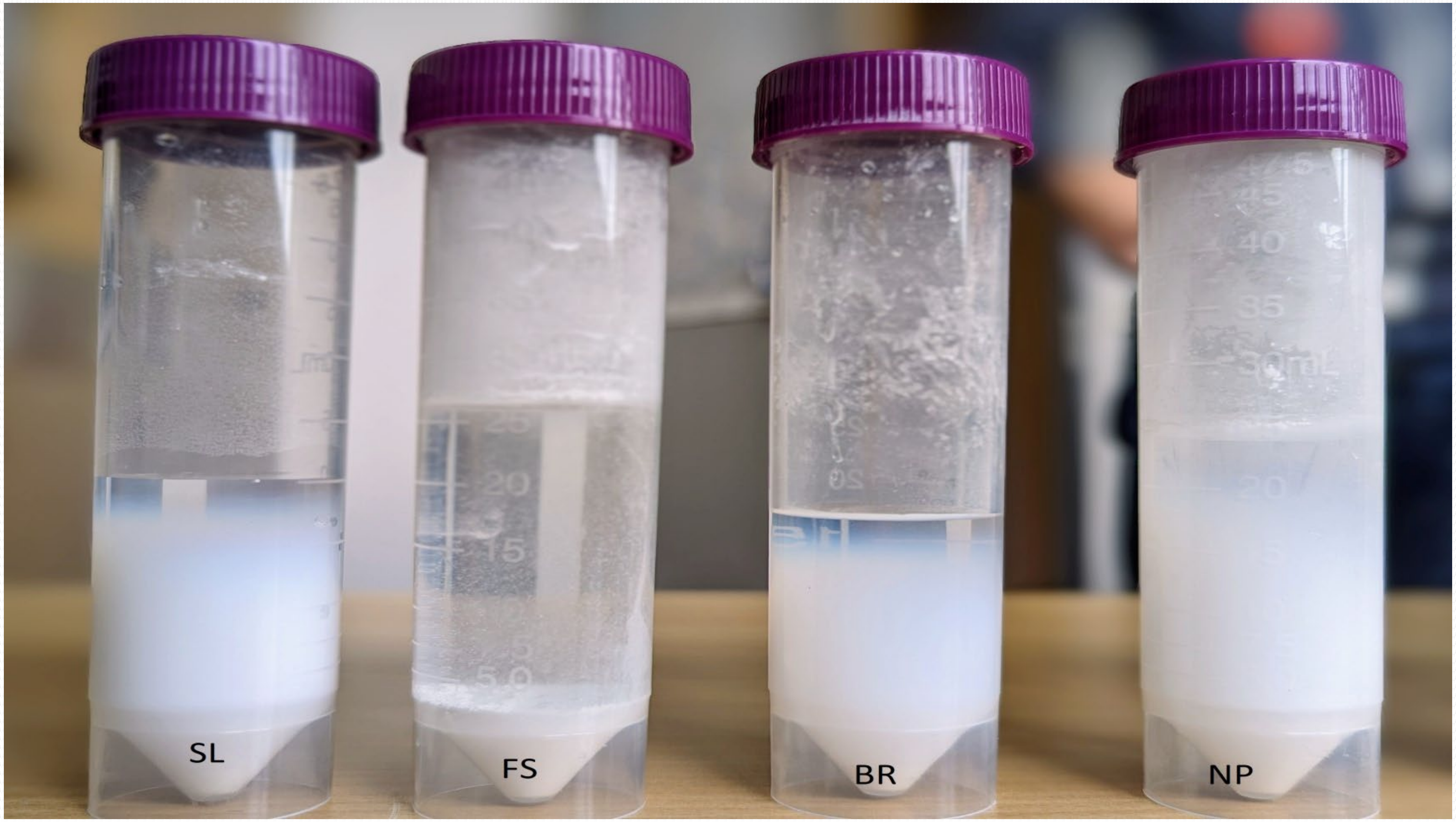



FIGURE 8. precipitation and aggregation states of ceria abrasives a

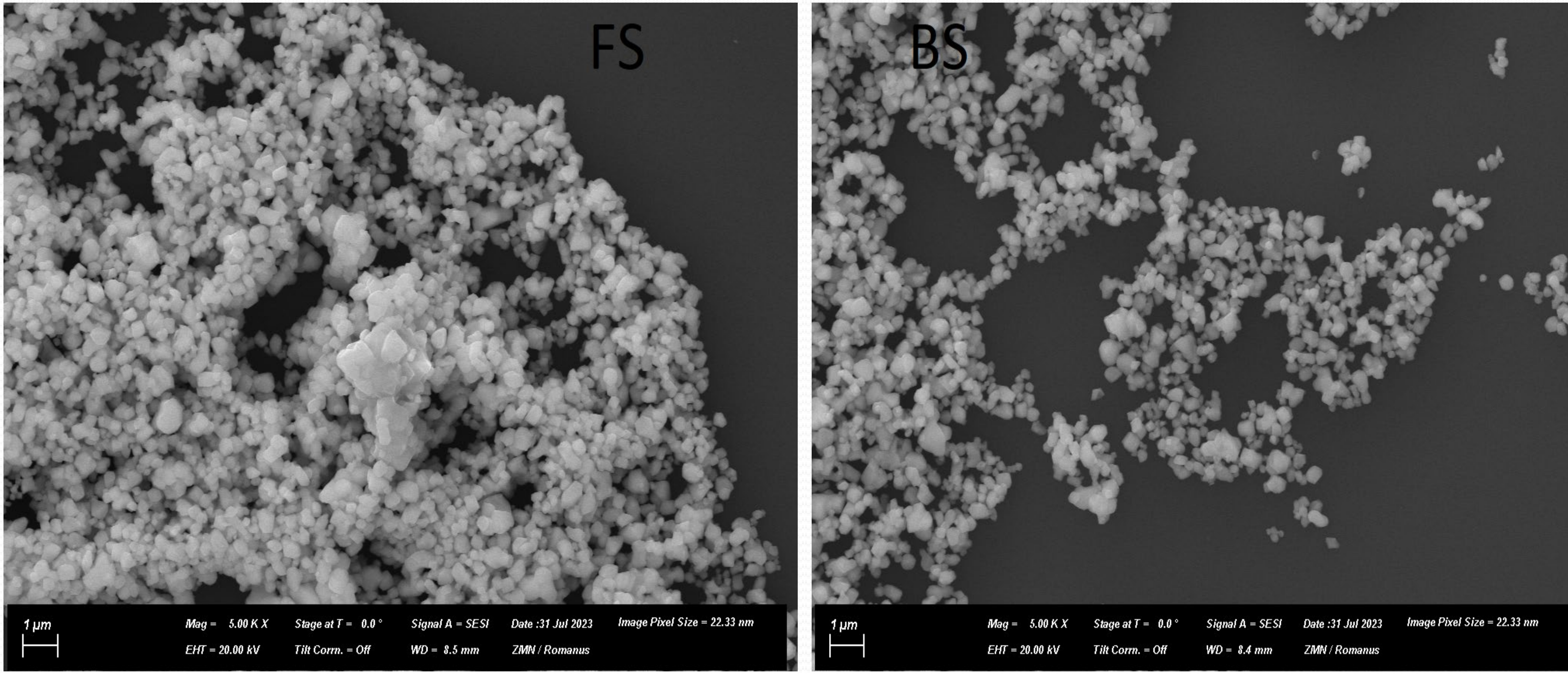



FIGURE 9. SEM pictures of a dispersed and aggregated ceria slurries

# Conclusion

- **Glass Composition Affects Polishing:** The study confirmed that the chemical composition of glass has a significant impact on the ceria slurry polishing process. Glasses with alkaline elements exhibited noticeable pH changes post-polishing, indicating a chemical interaction between the glass and the slurry.

- **Particle Size Matters:** The size of ceria particles in the slurry played a crucial role in material removal rates. Larger particles resulted in greater material removal and more pronounced pH changes, demonstrating their effectiveness in the polishing process.

- **Slurry Stability and Zeta Potential:** Changes in zeta potential were observed in the slurry that exhibited pH changes. This suggests a connection between slurry stability and pH variations, potentially influencing the polishing efficiency.

- **Optimization Potential:** The findings suggest opportunities for optimizing the ceria slurry polishing process by tailoring slurry composition and particle size to the specific glass types. This optimization can lead to more efficient and controlled glass polishing procedures.

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