EFFECTIVE SLURRY MIXING AND HANDLING AND ITS IMPACT ON CMP SLURRY PARTICLE HEALTH

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Carlo Aparece, Koh Murai, Laura Philips and Fook Chiong Cheong
caparece@megafluidsystems.com
kmurai@megafluidsystems.com
lphilips@spheryx.solutions
fcheong@spheryx.solutions

MEGA
KINETICS FLUID SYSTEMS

Spheryx

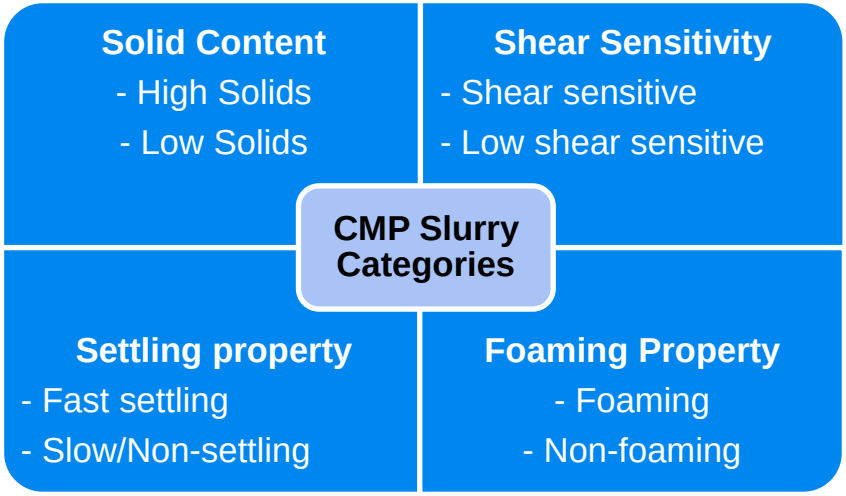
AGENDA

BACKGROUND
- Slurry Mixing and Handling Challenges
- Slurry Distribution Systems Overview

DATA AND DISCUSSION
- Long Term Slurry Recirculation Study
- Particle Health Data Analysis from Spheryx

KEY TAKEAWAYS
- Conclusions
- Acknowledgements
- Authors/Presenters Biography

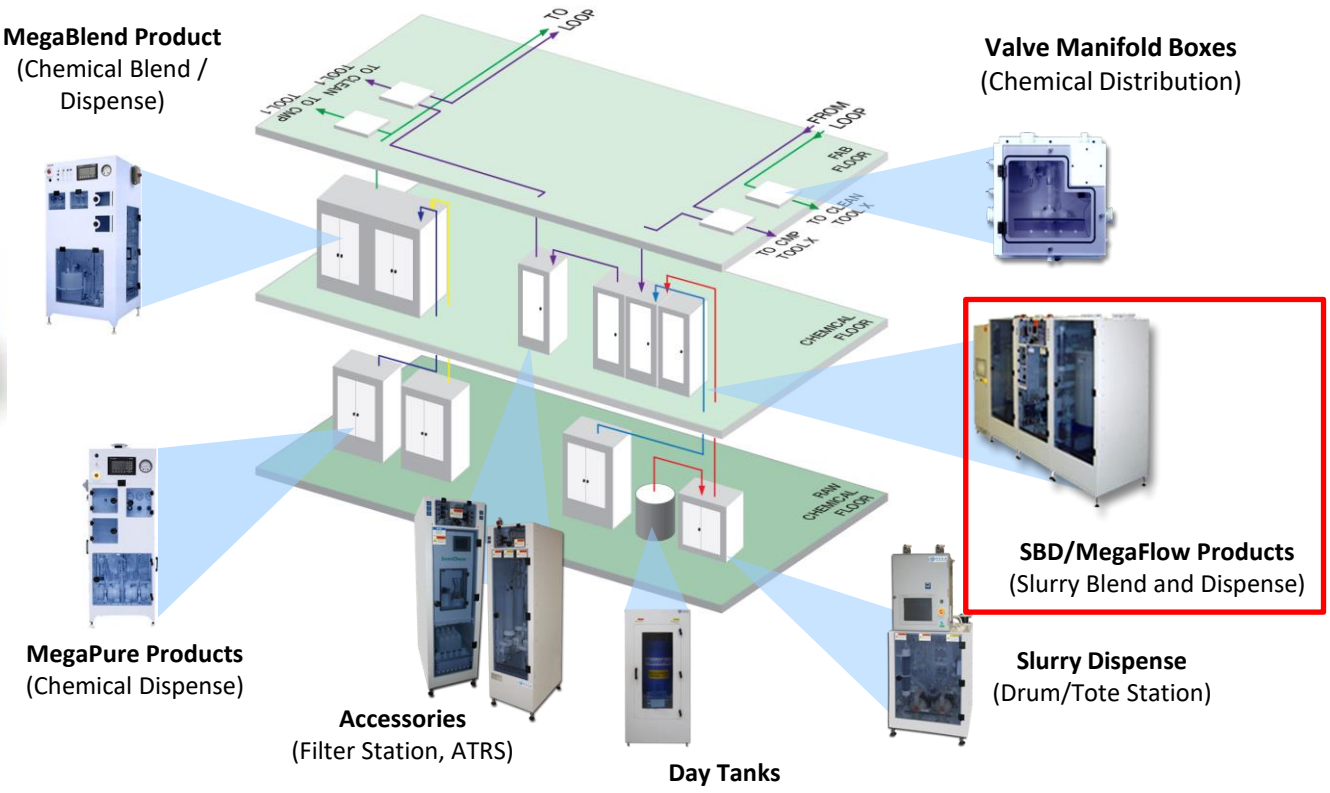
SLURRY MIXING AND HANDLING CHALLENGES



M. Maxim (2015)

- The distinct slurry properties that are unique to a specific CMP slurry formulation are the main drivers on how it needs to be homogenized before it is supplied to the Polishers.
- These unique slurry properties are also the determining factors on how each respective slurry is homogenized.
- The degree of how well a CMP slurry is homogenized prior to use at the Point of Use (POU) affects how well the CMP process performs in terms of quality and yield:
    - CMP process defects
    - Polishing performance

SLURRY DISTRIBUTION SYSTEMS OVERVIEW



A typical Fab layout incorporating the various Mega Fluid Systems product lines supporting the CMP Process.

- Key study focus will be on the effects of slurry mixing and handling at the Slurry Blend and Distribution System.

SLURRY DISTRIBUTION SYSTEMS OVERVIEW

MF-Trio (& Duo) Slurry Blend & Distribution

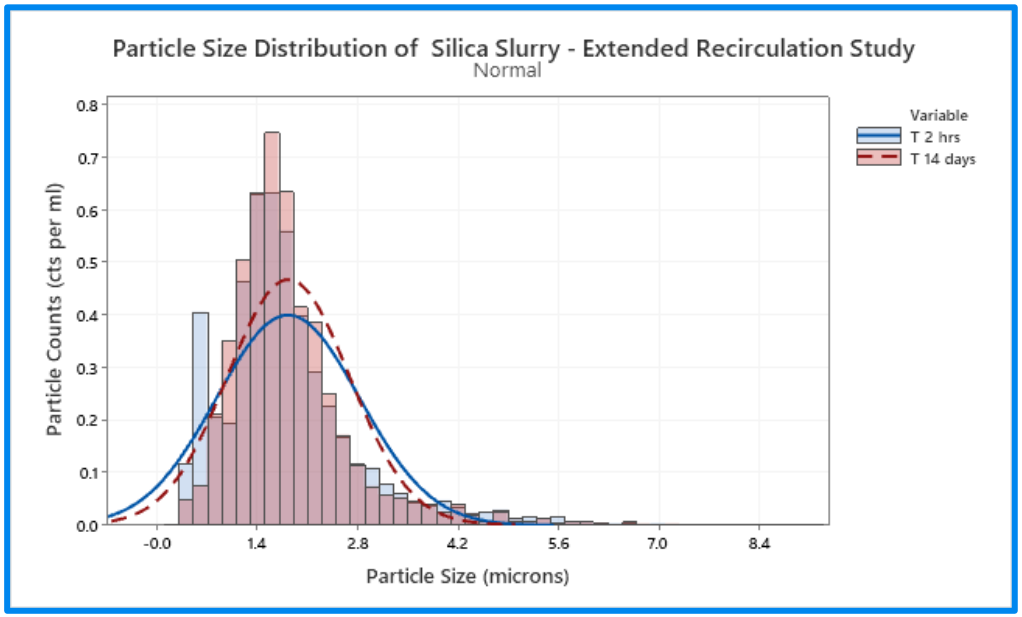
Proprietary tank eductor set-up in MFS Slurry Tank showing simulated liquid flow path.

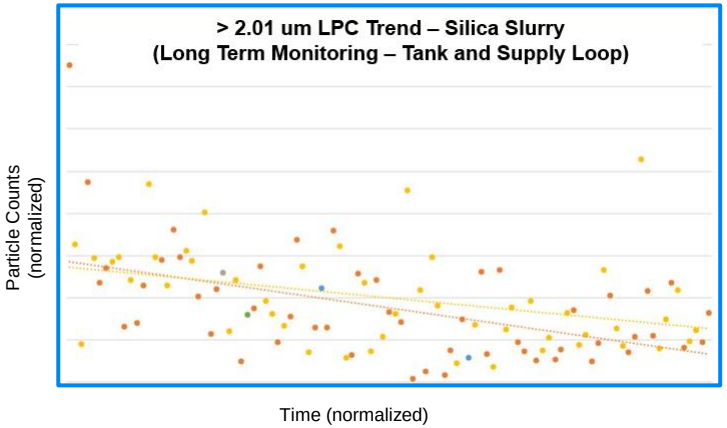
- Mega's MF-Trio Slurry Blend and Distribution Systems use proprietary eductor technology in the Blend/Day Tanks to keep slurry mixture homogeneous.
  - The resulting liquid turbulence created in the tank promotes the efficient dispersion of the CMP slurry mix without the aid of external devices.
    - No stirrers or mixers are employed in the tank.
      - This drastically lowers the Equipment's Cost of Ownership due to lesser number of auxiliary equipment and lower maintenance cost.

LONG TERM SLURRY RECIRCULATION STUDY

SILICA SLURRY CASE STUDY:

- Test conducted to show effectiveness of a MF-Trio Slurry Blend and Dispense System set-up in keeping the slurry mixture in suspension and preventing LPC formation.
- Local tank recirculation (no filters) duration was set at 2X the customer's standard slurry pot life.
- Key criteria was to monitor formation of Large Particle Count (LPC) or shift in the Particle Size Distribution of the slurry mixture in local recirculation.





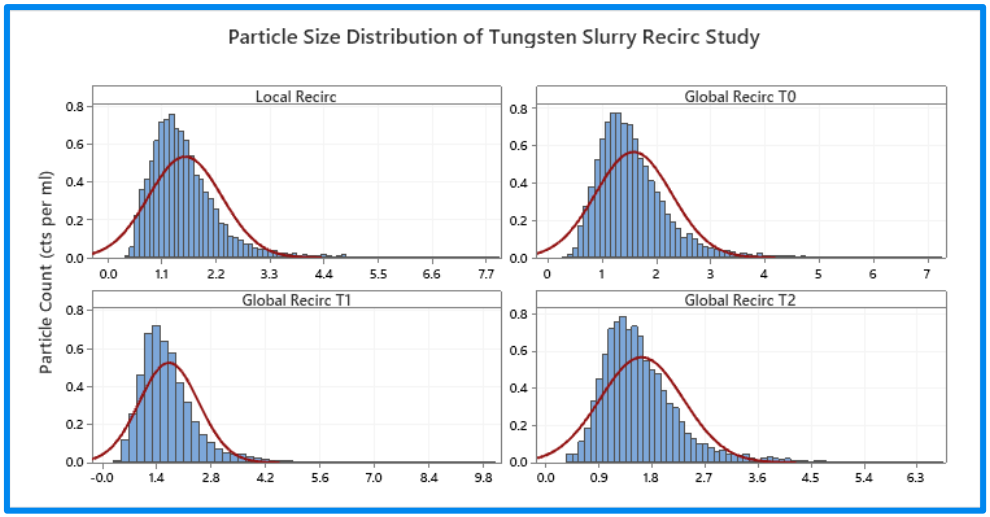
LPC Trend data of the same silica slurry under extended recirculation in a non-MEGA system showing unstable LPC trend.

- No significant shifts in the slurry PSD and no abnormal LPC formation were observed during the duration of the study.

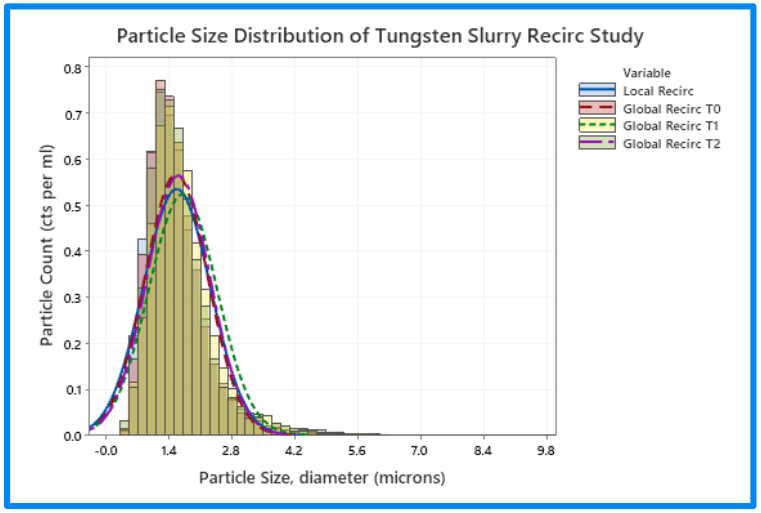
LONG TERM SLURRY RECIRCULATION STUDY

SILICA (TUNGSTEN) SLURRY CASE STUDY:

- Test conducted to show effectiveness of a MFS Slurry Blend Tank System set-up in keeping the slurry mixture in suspension and preventing LPC formation.
- Local and global recirculation (with filters) duration was set at 4X the customer's standard slurry pot life.
- Key criteria was to monitor formation of Large Particle Count (LPC) in the slurry mixture during the recirculation study.



Individual histograms of slurry samples taken at key timelines during the Extended Slurry Recirc Study.



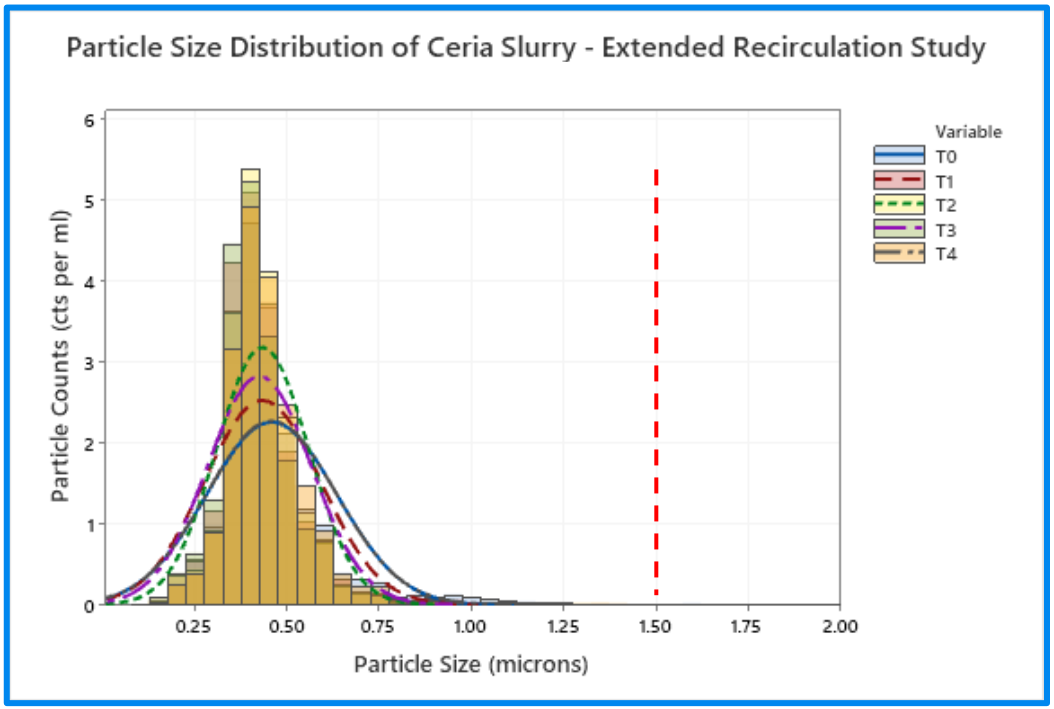
Overlay of PSD histograms of slurry samples taken at key timelines during the Extended Slurry Recirc Study to compare shifts in PSD.

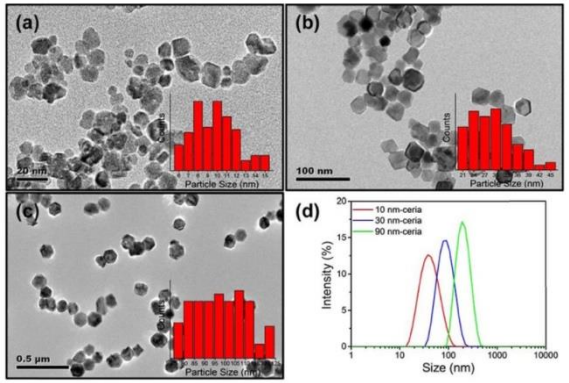
- The PSD data of the different samples taken throughout the course of the recirculation study shows no indication of large particle (LPC) formation.

LONG TERM SLURRY RECIRCULATION STUDY

CERIA SLURRY CASE STUDY:

- Low solids ceria slurry requiring aggressive agitation to keep abrasive particles in homogenous suspension.
- Tank Recirculation duration was set at 3X the standard slurry pot life.
- Key criteria was to monitor formation of Large Particle Count (LPC) or shift in the Particle Size Distribution of the slurry mixture over time.



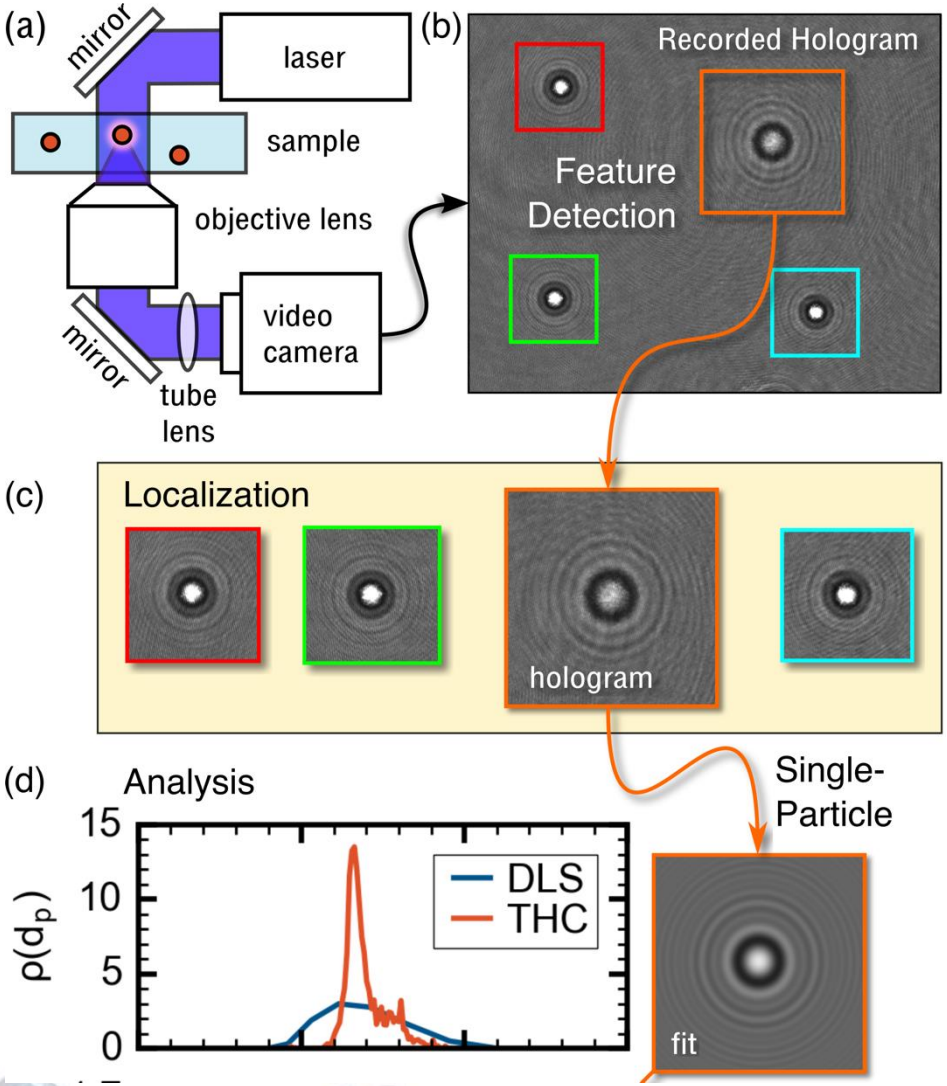


J. Seo (2018)

Reference image of ceria particles showing morphology and size distribution of ceria particles.

- No significant shifts in the slurry PSD and no LPC formation were observed during the duration of the study.

SPHERYX'S TOTAL HOLOGRAPHIC CHARACTERIZATION®



Total Holographic Characterization® (THC)

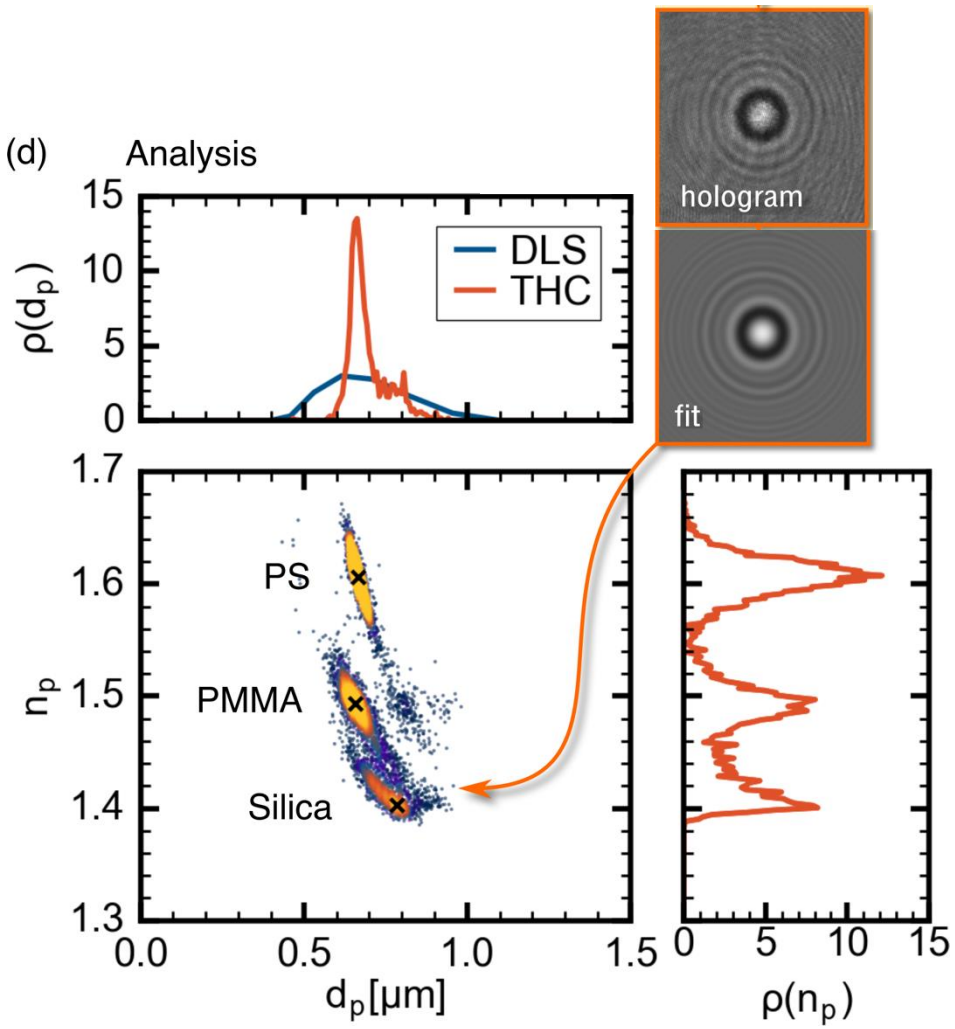
a) Measure: Particles flow through laser beam in a microfluidic channel

b) Record: Microscope records holograms

c) Detect: Each hologram is detected and localized

One particle ⇒ One hologram

A NEW DIMENSION OF INFORMATION



d) Spheryx's software fits hologram to theory of light scattering

Each fit yields

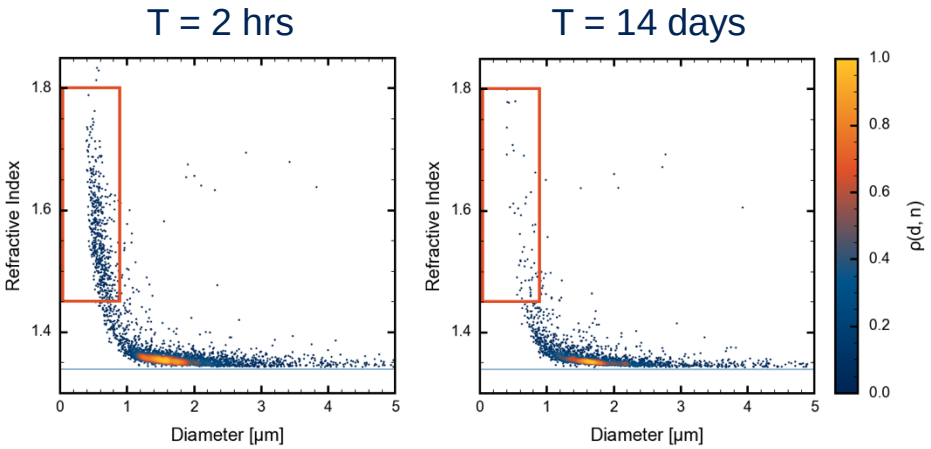
- diameter: d_p
- refractive index: n_p
- 3D position
- symmetry

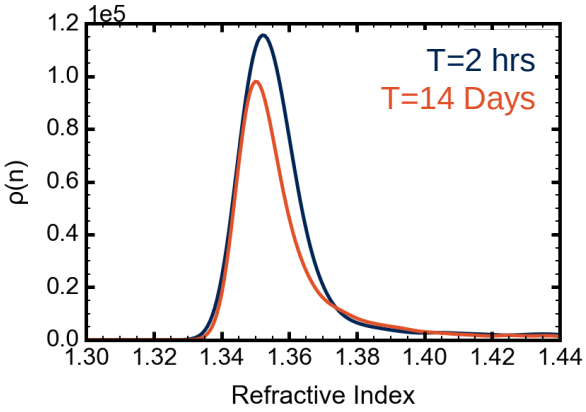
One particle ⇒ One point

Repeat to build Statistics

Conc. = # of particles/vol.

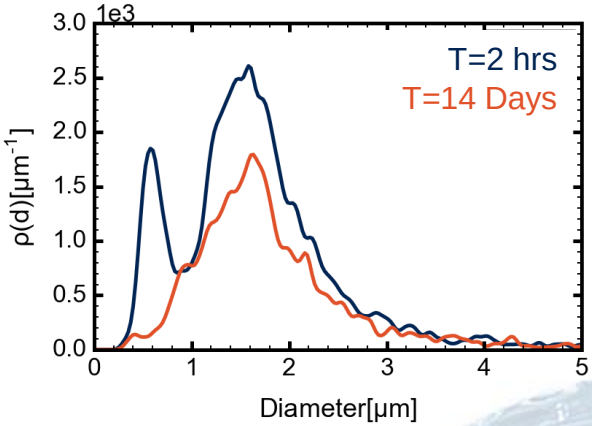
THC OF SILICA SLURRIES WITH SPHERYX'S xSIGHT





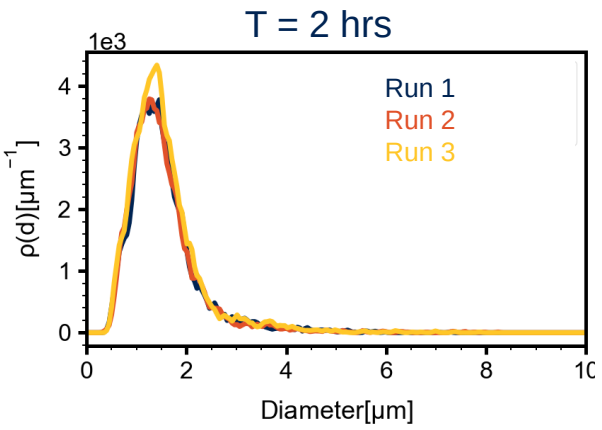
Long term silica slurry recirculation study
Particles identified by size and index

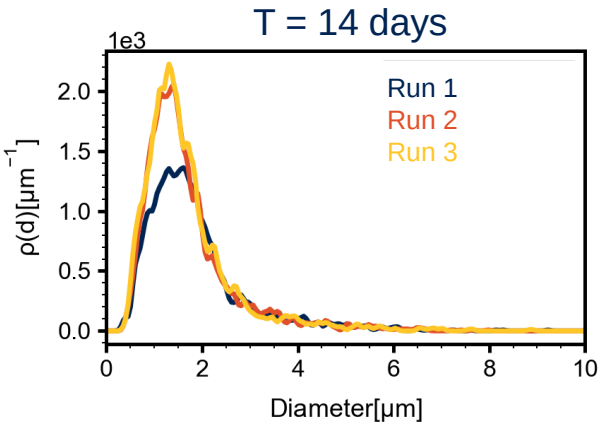
- Scatter plots show detail of regions of interest
- High index vs. low index particles represent different morphologies
- Reversible vs. non-reversible particle formation
- No dilution needed for silica slurries

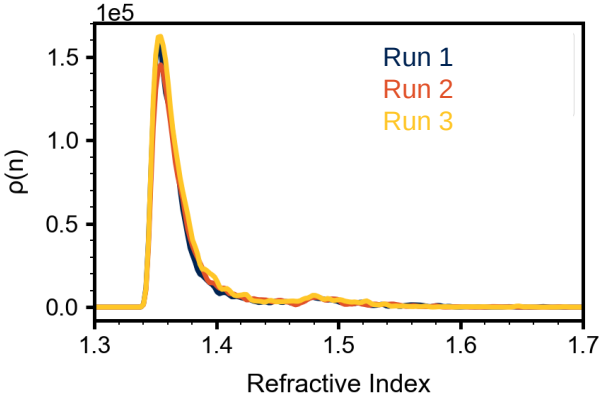


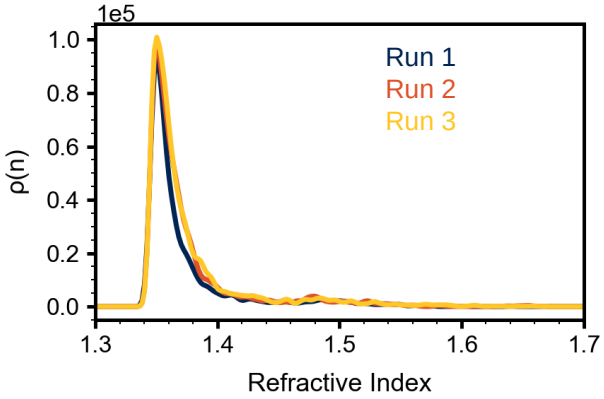
LONG TERM SILICA SLURRY RECIRCULATION STUDY

Measurement to Measurement Reproducibility



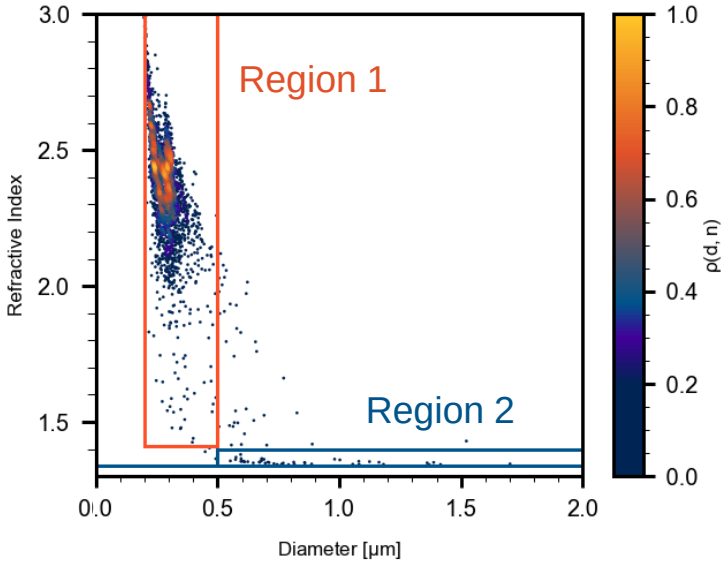


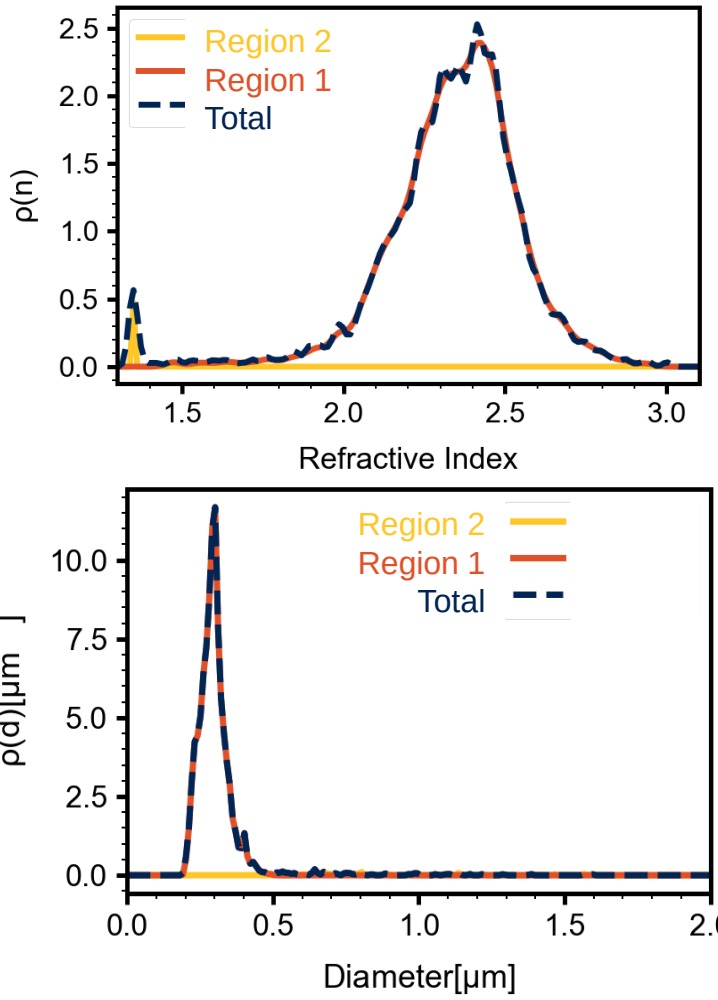




- Excellent run-to-run reproducibility in size and index distributions

THC OF CERIA SLURRY USING SPHERYX'S xSIGHT





Particles identified by size and index

- 2 particle types present
  - Native slurry particles
  - Larger low index particles
- Particle types not identifiable with size alone
- Easy to identify with index
- Dilution needed for ceria slurries

CONCLUSION

Mega's Slurry Blend and Distribution Systems are able to achieve good slurry dispersion and maintain slurry particle health which has been validated by Spheryx's xSight technology.

The CMP Operation benefits from the low Facilities Equipment Cost of Ownership and the reduced quality defects from the supplied slurry which is maintained and monitored at optimum conditions.

Mega Fluids Slurry Systems in conjunction with Spheryx technology sets a new BKM for optimum slurry particle health performance.

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- Juliana Lumer, Scientist, Spheryx, Inc.

AUTHORS/PRESENTERS BIOGRAPHY

Carlo Aparece

Carlo Aparece is the Director of Process Integration for Mega Fluid Systems, a chemical and slurry delivery equipment subsidiary of Kinetics that serves the semiconductor, LED, pharmaceutical, specialty chemicals and solar/PV industries. Prior to joining Mega, he has spent over 20 years in the semiconductor industry in Asia and the US in varying roles as Process Engineer, Facilities Chemical Engineer and Member of Technical Staff for chemical and slurry distribution systems and Quality Materials Lead for CMP Materials and Processes .

Laura Philips

Laura A. Philips is the Founder, President and CEO of Spheryx, Inc. She has spent time on the faculty at Cornell University, in government, and has spent the last 20 years in the private sector in the materials and biotech industries.