INLINE REFRACTIVE INDEX-BASED SLURRY DENSITY MONITORING TO OPTIMIZE RAW CMP SLURRY CONTAINER DISPERSION

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INTRODUCTION

Effective dispersion of the raw CMP slurry drums is required to ensure slurry is homogeneous prior to delivery in its final form at the point-of-use (POU). Dispersion of the raw slurry mixture is attained by various methods as recommended by the slurry manufacturers. Dispersion time is managed by a pre-determined timed setpoint based on key slurry health indicator.

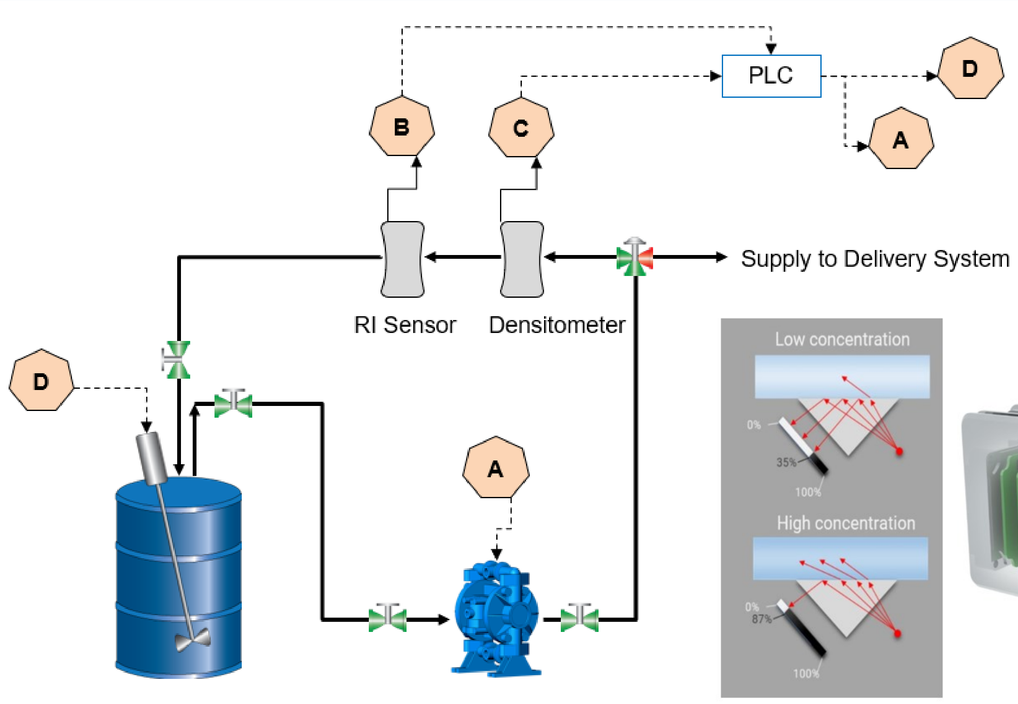
One of the key slurry health indicators used to gauge slurry abrasive homogeneity is density or specific gravity. Improper mixing of incoming slurry containers (pails, drums, totes) is one of the possible sources of large particle counts (LPC) that could potentially impact wafer quality. Ensuring a homogeneity of the slurry abrasives prior to supplying it to the POU tools reduces process defects and quality issues.

This paper presents the effectiveness of incorporating an inline Refractive Index (RI)-based slurry density monitor and feedback system in the recirculation line during the raw CMP slurry dispersion step.

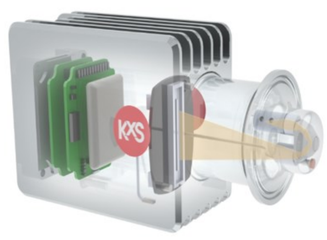
EXPERIMENTAL

Three types of CMP slurry abrasives were prepped in a **Mega Essex™** Slurry Transfer Station based on the slurry manufacturer's recommendations. Readings from an oscillating U-tube density meter serve as reference metrology. A preliminary comparison of the RI sensor readings and reference density metrology readings was conducted to check for fitness of data prior to running the inline measurement monitoring.

The Raw Slurry Recirculation Unit concept as shown in the figure below shows the feedback to the Transfer/Recirc Pump (A), the feedback to the Drum Mixer (D) as well as the output signals from the KxS RI sensor (B) and the reference densitometer (C).



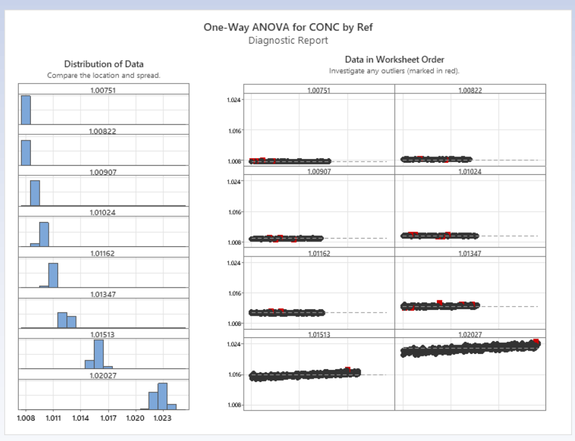
Drum recirculation station showing the density metrology set-up and PLC feedback system.

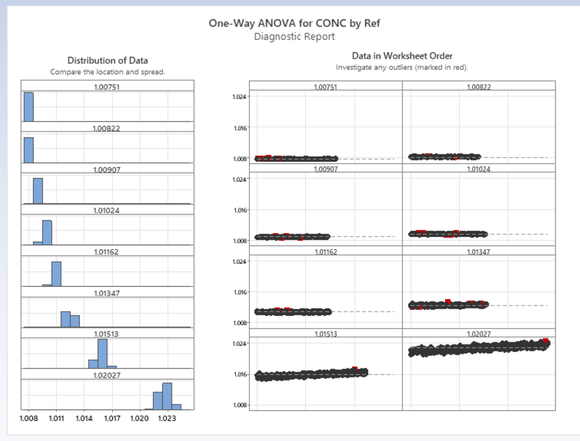


Overview of KxS DCM RI-based concentration sensor's operating principle.

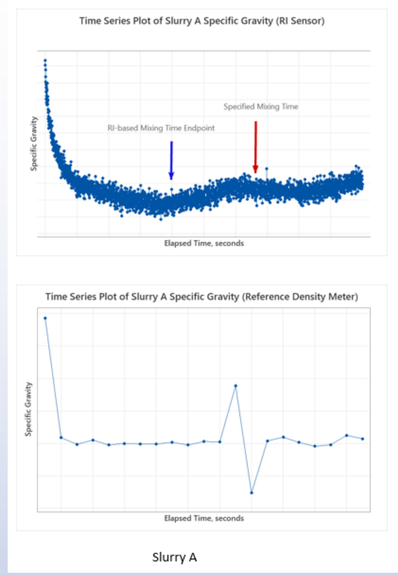
RESULTS

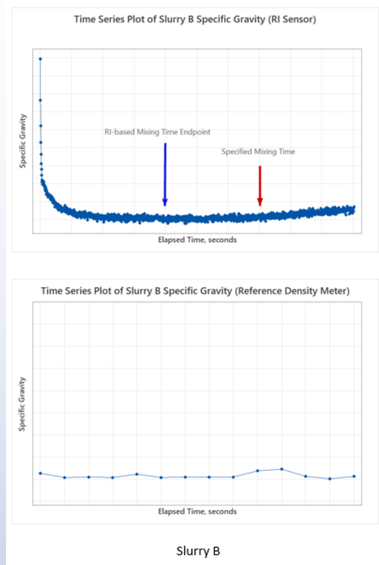
Density readings from the RI sensor were statistically comparable to the reference metrology across the different slurry samples based on the results of the Analysis of Variance (ANOVA) Test.

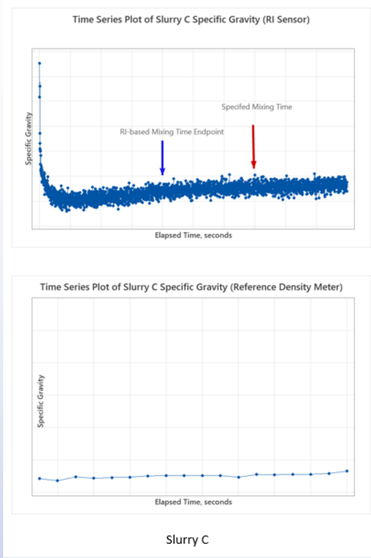




The RI sensor was less susceptible to pump flow and pressure fluctuations versus the reference metrology. The charts below shows the comparison of the possible mixing time reduction of CMP Slurries A, B and C based on the RI-based trend versus the fixed mixing time as per initial specification. Mixing Time Endpoint is achieved once stable density/specific gravity reading (+/- specified control limits) is monitored for a given window period.







The results effectively demonstrate that the dispersion of raw CMP slurries can be effectively characterized by the KxS RI sensor. Incorporating the feedback system to manage the dispersion time based on the RI sensor's output signal provides a real-time health indicator of the raw slurry under dispersion. This data-driven approach would be a viable option for process and operational improvements for Fab Facilities Operations teams.

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