INLINE REFRACTIVE INDEX REPLACES AUTO-TITRATION IN QUALIFYING H2O2 CONCENTRATION IN CMP OF TUNGSTEN

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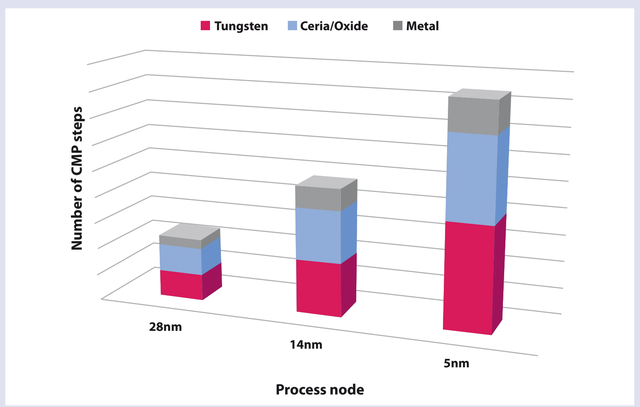
Abstract

Refractive index measurements have established themselves as the technique of choice for qualifying peroxide content in slurries for CMP of tungsten. Many emerging process flows use CMP as a critical tool for building circuit structures, dramatically increasing the number of CMP steps — and thus the number of opportunities for yield loss if slurry composition deviates from the specification. While auto-titration measurements can give extremely accurate results, they impose large capital equipment and ongoing maintenance costs and offer only discrete sampling at specified intervals. Refractive index, a continuous, non-slurry-consuming measurement, helps fabs identify slurry composition faults quickly, reducing the number of wafers at risk. Once calibrated to a specific slurry's temperature/refractive index characteristics, refractive index measurements can determine the concentration of hydrogen peroxide in tungsten slurry to within ±0.03% by weight. Moreover, unlike conductivity probe tests, refractive index measurements can monitor slurry density, an indicator of settling and degradation of the slurry over time. Therefore, refractive index is used to qualify not only the final product for supply, but also to monitor batch to batch variation of incoming raw slurry and validate the blend addition steps.

In long-term studies at a leading-edge analog device fab, refractive index measurements have replaced auto-titration in qualifying H2O2 concentration in slurry delivery systems. The measurements have remained stable for four years with no instrument maintenance beyond routine flushing of the slurry blender. An attractive feature in some slurry delivery systems has been the ability to use an automated chemical spiking function in the day tank.

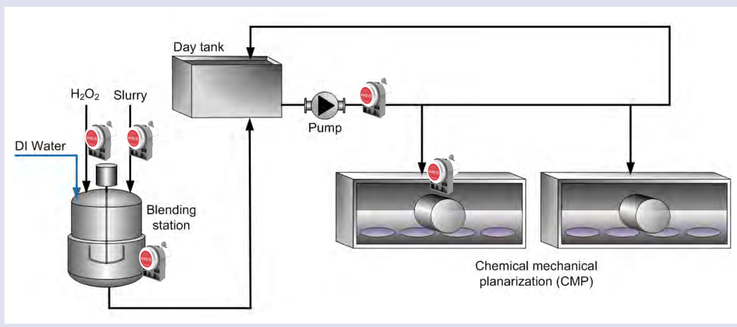
Introduction



In sub-28nm processes the number of CMP steps are increasing and the slurry feed has become fast paced. In situ refractive index measurements have become the industry standard for fast, accurate, inline CMP slurry monitoring.

Methods

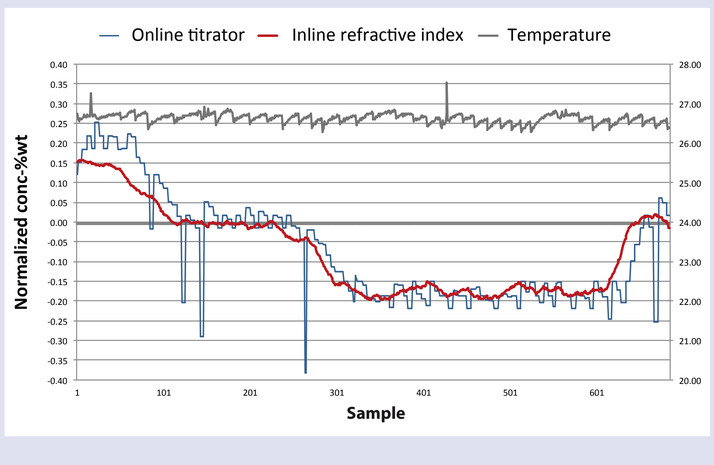
Refractive index monitors are typically installed on the incoming hydrogen peroxide and raw slurry supplies, at the blending tank, and on the process feed.



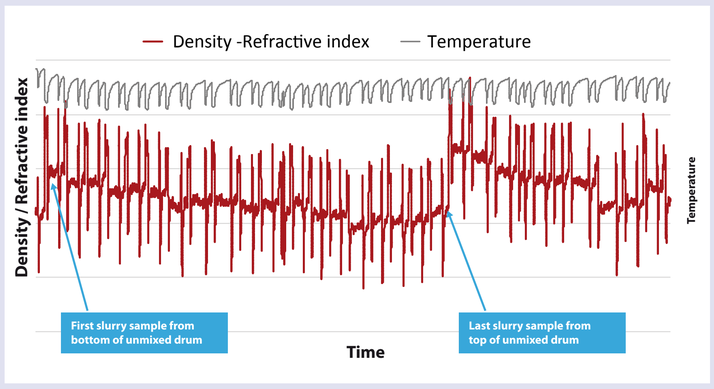
The Slurry Delivery System SDS uses a concentration set-point with monitoring of high and low values, creating a trigger on/off point. The chemical dispense valve opens and closes when below or above the established low point. This creates a pulsing injection cycle of H2O2 flow that decreases as the sensor sees the increase in H2O2 concentration over time, until the monitored value is above the low point.

Results

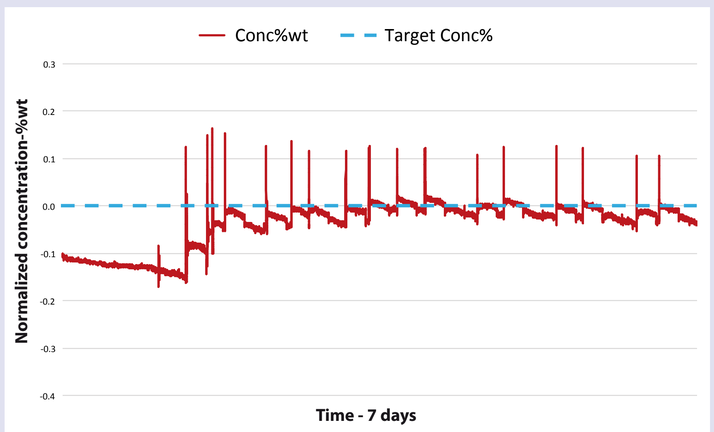
Inline refractive index monitoring is continuous. As such, it provides a more accurate picture of variations in slurry composition than any discrete sampling method can.



Monitoring of the incoming raw material, during blend addition steps in the blending tank in particular can identify settling and stratification of the slurry particles as well as changes in chemical composition.



The slurry delivery system (SDS) "spikes" the day tank with hydrogen peroxide to maintain the desired concentration.



Conclusion

As advanced process nodes bring increasing numbers of CMP steps, fabs must ensure that the slurries delivered to their polishing tools maintain consistent chemical and mechanical characteristics. Inline refractive index monitoring can evaluate chemical composition of incoming material, qualify blend addition steps, and validate a uniform CMP slurry blend in a single real-time, non-slurry-consuming measurement.

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