# Colloidal Aspects of CMP

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Chemical mechanical planarization (CMP) utilizes dispersions of colloidal particles in a slurry to maximize material removal rate with a high degree of uniformity in integrated circuit manufacturing. Since the synergistic effect of the abrasive action and chemistry is responsible for significant removal during CMP [1], it is important to understand the chemical and colloidal details of the process. The goal of our research is to optimize the slurry concentration and chemistry from an investigation of the behavior of the abrasive slurry particles by measurement of surface charge or zeta potential of the particles. If the zeta potential is a large value, the colloidal particles will remain dispersed and in suspension. If the zeta potential is small, agglomeration and even settling of particles may occur. It has been shown that the type of colloidal particle used in the slurry has a large effect on material removal rate [2]. Modification of the suspending liquid can control zeta potential. Our investigations include changing the solution pH, ionic strength, or the ionic species in solution and measuring the zeta potential.

The zeta potential of dilute aqueous suspensions was measured with PenKem zetameter with an accuracy ~ 5mV. The zeta potential of commercial slurries were compared with that of additive-free alumina particles (Ceralox®, 300 nm diameter). Commercial alumina slurries exhibited different zeta potential behavior than did pure alumina in de-ionized distilled water as a function of pH as shown in Figure 1. Although the commercial slurries have similar iso-electric points as the pure alumina, the commercial slurry showed more stable behavior, especially below pH 8.

The effects of glycine used in copper CMP as a stabilizing agent in alumina slurries were also studied. Figure 2 shows that the commercial alumina slurry with $10^{-2}$ M glycine had an iso-electric point and zeta potential behavior that was more similar to that of the additive-free alumina slurry. It is also worth noting that adding glycine to the solution stabilized the ionic strength of the solution.

## Acknowledgments

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## References:

1. G. Yehiel and R. Kistler, Electrochemical 198th Society Meeting Abstracts, Vol. 2000-2, No. 496 (2000).
2. D.J. Stein, D.L. Hetherington, and J.L. Cecchi, J. Electrochem. Soc., **146**,1934 (1999).

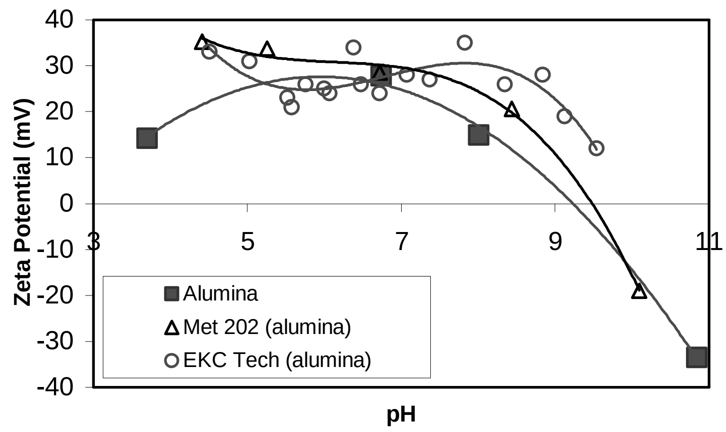


Figure 1. Zeta potential vs. pH for pure alumina and commercial alumina slurries (EKC Tech, Met202) in distilled de-ionized water

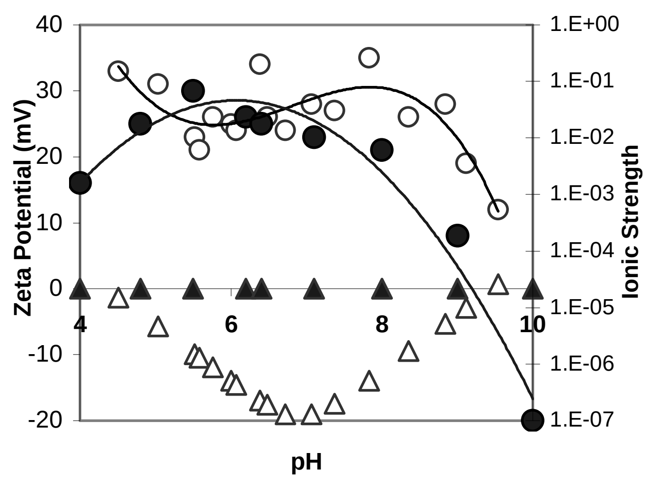


Figure 2. Zeta potential (o) and ionic strength (Δ) vs. pH for alumina with (closed points) and without (open points) $10^{-2}$ M glycine.