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Influence of anionic polyelectrolyte addition on ceria dispersion behavior for quartz chemical mechanical polishing

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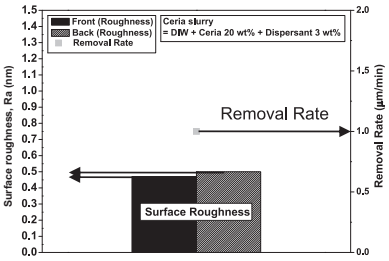
HIGHLIGHTS

- New ceria chemistry with additive (PAMS) is proposed for quartz CMP.
- We report the adsorption behavior of PAMS on ceria and slurry stability behavior.
- The viscosity and electro kinetic behavior is different from other common additives.
- The mechanism explains ceria suspension behavior at various additive concentration.
- The desired surface quality of quartz could be achieved with the proposed chemistry.

GRAPHICAL ABSTRACT

Surface roughness and removal rates after quartz substrate polishing at an optimized ceria slurry condition.



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ABSTRACT

In this study, the effect of anionic dispersant, poly(acrylic acid-co maleic acid) sodium salt on ceria (CeO_2) slurry stability was investigated for quartz chemical mechanical polishing (CMP) applications. The properties of the ceria slurry, including pH, viscosity, and stability behavior as a function of dispersant concentrations (0.1, 1, 3 and 5 wt%), were characterized to identify optimized conditions for the polishing process. With the addition of dispersant, the pH of ceria slurry increased to an alkaline regime which is compatible for quartz CMP processing while the viscosity sharply increased at 5 wt%. The stability results show that the slurry is stable only at 3 wt%, whereas the particles become agglomerated and settle quickly at all other dispersant concentrations. Adsorption and electrokinetic behavior of the ceria slurry were measured to understand the ceria slurry behavior at various dispersant concentrations. At low concentrations, the dispersant does not protect the particles enough to overcome the van der Waals attraction forces, whereas, at higher concentrations, particle agglomeration occurs due to bridging flocculation. At the optimum concentration, the dispersant provides enough steric hindrance to overcome the attractive force. In addition, the presence of sodium ions in the dispersant also strongly influences the settling behavior of ceria particles. The polishing test showed that the desired removal rate and surface quality could be achieved with the optimized slurry.

1. Introduction

In semiconductor processing, lithography technology enables the formation of micro or nano patterns on substrates by specific optical sources. Photomasks with original patterns play a key role in the lithography process, which determines the performance of devices [1,2]. As such, stringent conditions must be met to

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