From Fundamental to Application: One Universal Solution Toward Highly Efficient PCMP Ceria Cleaning in Advanced FEOL Processing

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1 Introduction

With the semiconductor manufacturing pitches advance node, ceria based slurries have been widely applied to achieve rapid removal rates of silicon oxide (TEOS) in front-end-of-line (FEOL) chemical mechanical planarization (CMP) processing. In addition to the relatively strong chemical bond with the oxide surface, opposite charge and tiny size of ceria abrasive makes ceria post-CMP cleaning a greater challenge than before. As a result, formulating chemistry starts to emerge in market and gradually replaces commodity chemistry such as diluted HF(dHF), ammonia SPM and SC1, in both logics and memory applications.

2 Fundamental

Two templates EKC-CE072 and EKC-CE150 have been developed and demonstrates their capability on SiN and TEOS cleaning, respectively. Considering to replace commodity chemistry such as SC1 as well as acidic POR in customer side. One universal solution toward varying cleaning issue is urgently needed.

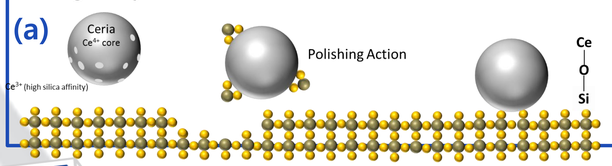
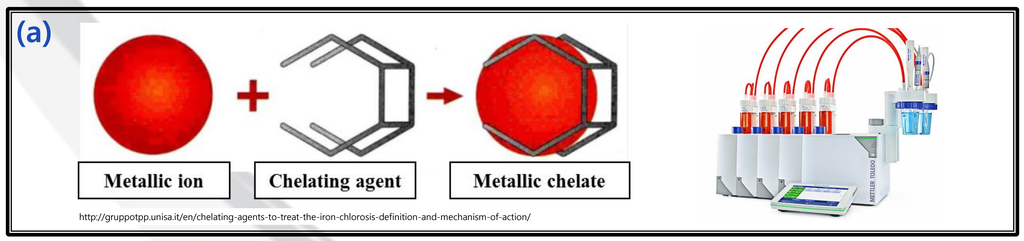


Figure 1. (a) Ceria CMP Processing and **(b)** cleaning performance of EKC-CE150, as well as EKC-CE072 versus POR

3 Inspection Methods



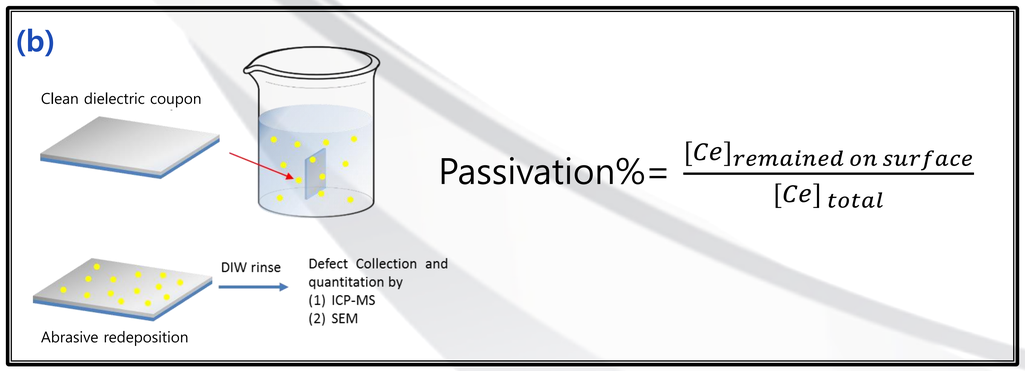
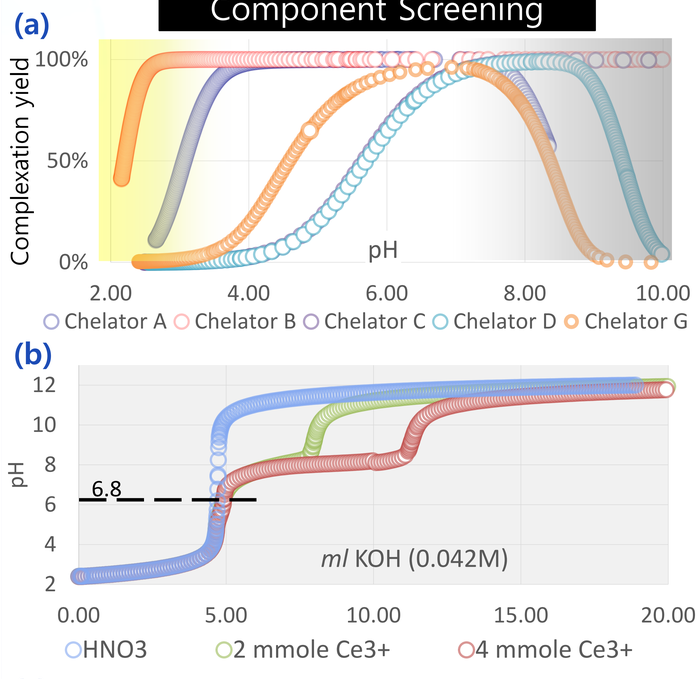


Figure 2. (a) Titration-based technique as the chelator screening methodology and **(b)** methodology for abrasive-dielectric passivation inspection.

4 Results and Discussion

Component Screening



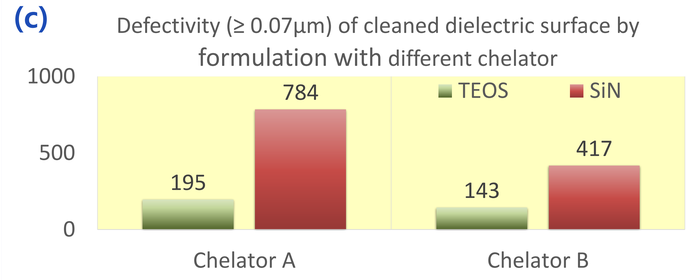


Figure 3. (a) Complexation behavior of Ce^{3+} versus varying chelators cross pH 2-10 ;**(b)** hydrolysis of Ce^{3+}, which explains the dropping of complexation yield for some chelators at pH above 7; **(c)** impact of chelation agent switching in cleaning performance, in which the POU of formulation is acidic.

Formulation Optimization

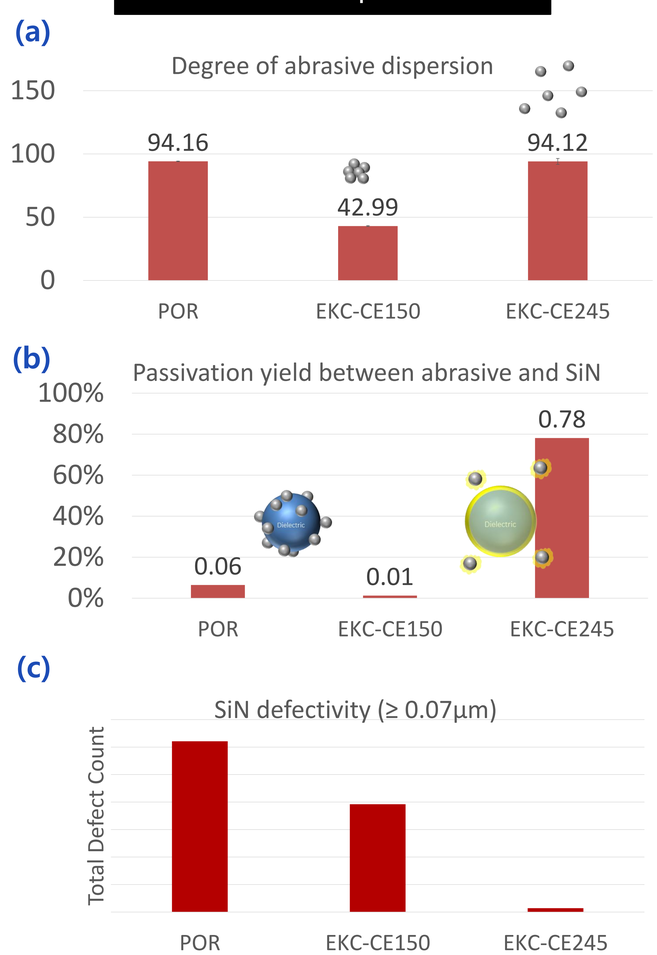
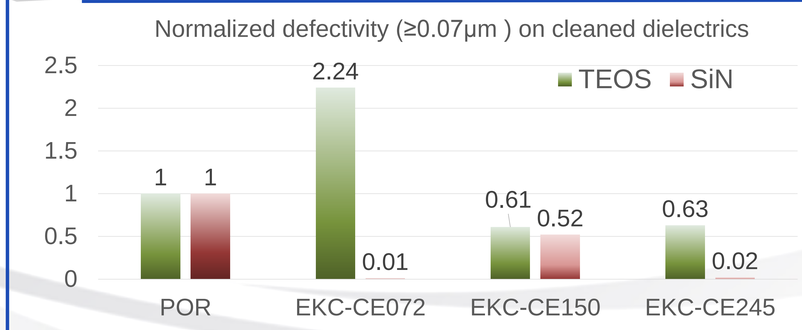


Figure 4. (a) Dispersion and **(b)** passivation capability of formulation. **(c)** Cleaning performance of corresponding formulation on SiN surface in practice.

5 Conclusions or Future Application



- Voltammetric titration method and filtration-based methodology provides more significant insight for PCMP processing such as the working window of cleaner formulation and abrasive behavior in formulating chemistry
- The ceria cleaner solution EKC-CE245 is developed by synergizing strength of EKC-CE072 as well as EKC-CE150.
- Compared to commercial POR, EKC-CE245 can achieve 37% and 98% reduction in defectivity on TEOS and SiN surface, respectively.

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