Achieving Wide Selectivity Window by Additive Interactions of Ceria Slurry Formulation for Diverse STI Processes

Yang-Yao Lee[1] and Ming-Che Ho[2]
[1] Vibrantz, simon.lee2@ferro.com
[2]Vibrantz, gary.ho@ferro.com

STI (Shallow Trench Isolation) is the most advanced isolation technology which is still in the state of art due to the well contrability of isolation width leading to improved transistor density [1]. For instance, it exists in the most advanced node such as 3 nm logic devices. Among many manufacture processes for STI formation, CMP (Chemical Mechanical Planarization) is the key to reach global planarization of STI structure which is the key quality of isolation capability. Cerium oxide (CeO_2) is the most common abrasive in STI CMP slurry because of intrinsically high removal rate of oxide and high oxide/SiN selectivity comparing to traditional silica slurry [2]. Due to the diverse pattern densities and feature sizes of modern IC chips including logic and memory devices (Please refer to Fig.1), the tunability of removal rate and selectivity is required to achieve global planarization of STI when considering wide range of WIDNU/WIWNU in terms of thickness of active oxide and underneath SiN stop layer [3] (Please refer to Fig.2).

Traditionally, CMP for STI formation is a 2 stepwise approach. First, removing the most oxide overburden using alkaline silica-based slurry with usually very high solid content (10-13 wt%). Then a low solid CeO_2 slurry is used to stop on SiN layer because of its naturally high selectivity which is not provided by silica slurry. To enhance the control of SiN erosion and oxide dishing when removing active oxide, we adopted two functional additives into the formulation: nitride stop agent (NSA) and dishing control agent (DCA) (Fig. 3). This slurry design is not only worked for the 2nd step high selective CMP but sufficient for the 1st step oxide removal due to the high oxide removal rate. Therefore, it is a total solution for general STI CMP by a single slurry approach.

Although the high selectivity is the most essential criteria for the 2nd step polishing, the tunability of selectivity is also important for the adoption of STI process in different device applications. In this study, we demonstrated very wide selectivity window from 8 to 300 using this formulation design [Fig. 4]. By adjusting the amount of NSA and DCA at different pH within this formulation space, Vibrantz technologies could easily tune oxide/SiN selectivity to match the different selectivity requirements for diverse STI process including logic, DRAM, and Flash devices.

Corresponding Author:
Yang-Yao Lee
Tel: +1 315-536-3357
E-mail: simon.lee2@ferro.com
1789 Transelco Dr., Penn Yan, NY 14527, USA

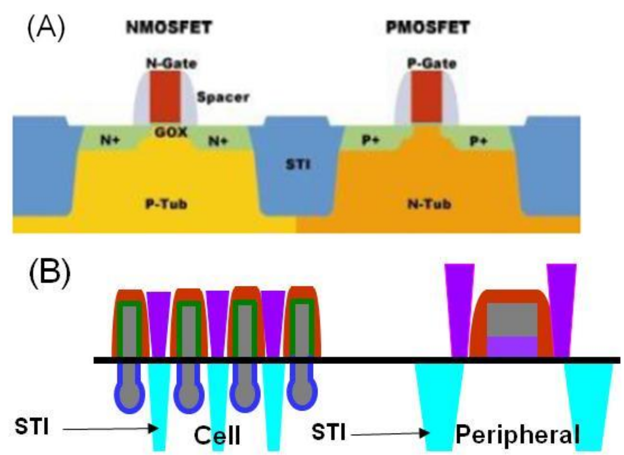

Fig.1 Typical STI structures in different devices (A) MOSFET (B) DRAM

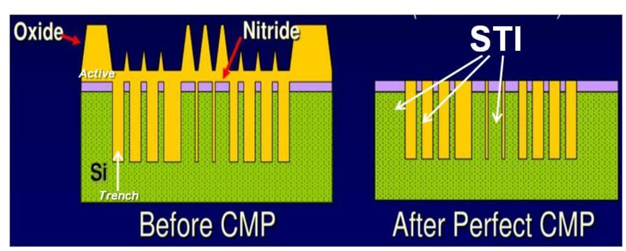

Fig.2 Typical STI CMP process (Please note the oxide/nitride topo non-uniformity resulted from different densities and features)

Fig.3 STI slurry design and working mechanism
(dual additives system)

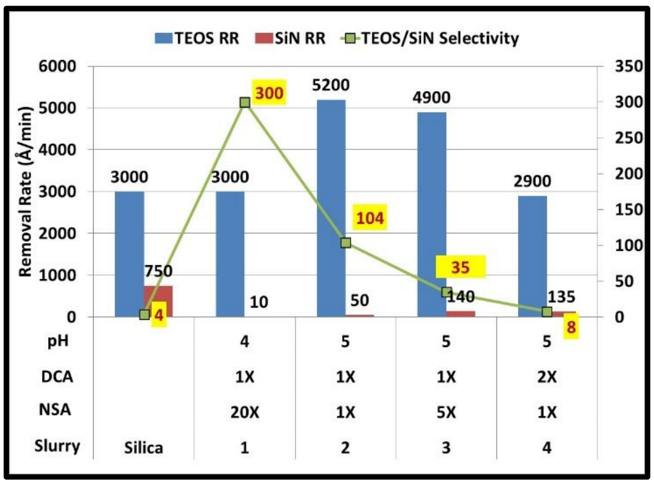

Fig.4 Tunablity window of the STI slurry formulation space; @ 3 psi, 93/87 rpm, 150 ml/min

References

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