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Invited

Gate Oxide Defects in MOSLSIs and Octahedral Void Defects in Czochralski Silicon

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1. Introduction

To increase yield and reliabilitiies of MOS LSIs and flash memories, the origin of the insulators's defects should be clarified for gate oxides, poly-oxides and buried oxides of SOI (Fig. 1). We found oxide defects originating in Czochralski Si (CZ-Si) [1], and then many reports have been written on this subject (Fig. 2) [1-8].

2. Experimental results

We developed a novel method (Cu decoration followed by focused-ion beam (FIB) etching) for observing the origin of gate-oxide defects and found octahedral void defects as the oxide defects (Fig. 3). We used laser-scattering tomography followed by FIB etching and observed octahedral void defects (~100 nm in size) in the bulk of the CZ-Si (Fig. 4) [9]. The defects were detected in Si by many Si vendors [7-8, 10] and also found in memory cells of actual MOS RAMs [11-12].

We applied the novel method for observing the defects in poly-oxides. Polyhedral void defects (~50 nm in size) were found on the poly-Si grain boundaries under the oxide defects for thermal SiO_2 or CVD SiO_2 (Fig. 5) [13]. We also applied the novel method for observing the defects in buried oxides of SIMOX with low oxide-defect density. Octahedral defects and polyhedral defects were found as the oxide defects (Fig. 6) [14].

3. Conclysion

Octahedral defects or polyhedral defects were found in gate-oxides, poly-oxides, and buried oxides (Fig. 7). Eliminating these defects is necessary for next-generation MOS LSIs.

References

[1] M. Itsumi et al., Appl. Phys. Lett., 40 (6), 496 (1982).
[2] Y. Matsushita et al., SSDM, 529 (1986).
[3] J. Ryuta et al., Jpn. J. Appl. Phys., 29, L1947 (1990).
[4] M. Itsumi et al., J. Appl. Phys., 78 (10), 5984 (1995).
[5] M. Miyazaki, et al., Jap. J. Appl. Phys., 34, 6303 (1995).
[6] T. Ueki et al., SSDM, LA-1, 862 (1996).
[7] M. Kato et al., Jpn. J. Appl. Phys., 35, 5597 (1996).
[8] M. Nishimura et al., J. Electrochem. Soc., 143, L243 (1996).
[9] T. Ueki et al., JJAP., 36, 552 (1997).
[10] T. Mera et al., MRS Fall Meeting, E8.2 (1996).
[11] Y. Furumura, Proc. of the 2nd Int. Symp. on Advanc. Sci. & Tech. of Si Mater. (Nov., Hawaii), 418 (1996).
[12] H. Yamamoto et al., ibid., 425 (1996).
[13] M. Itsumi et al., J. Electrochem. Soc., 144(2), 600 (1997).
[14] M. Itsumi et al., ibid., 143(7), 2357 (1996).

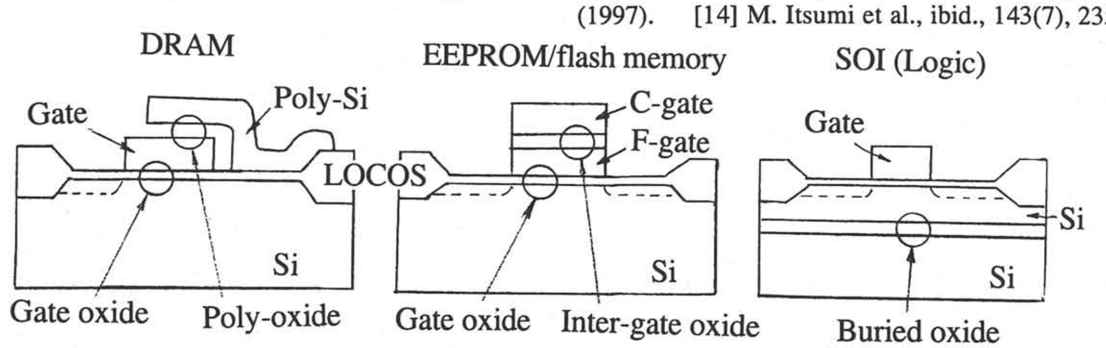

Fig. 1. Insulators used in various MOS LSIs

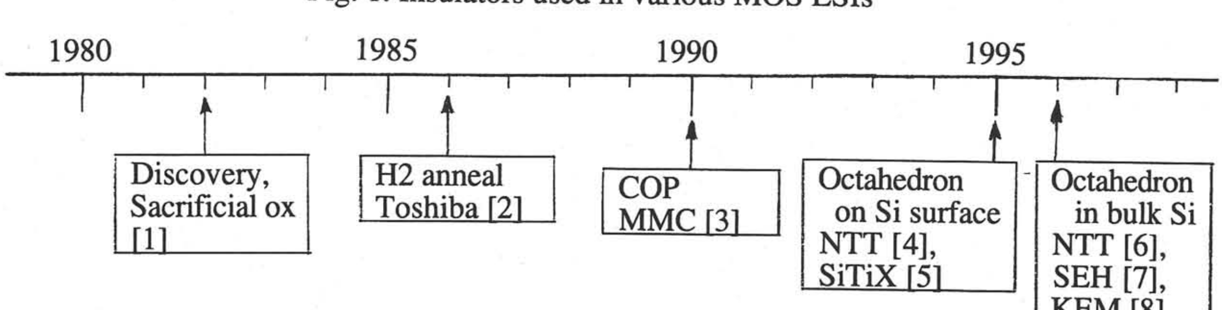

Fig. 2. Important works on gate-oxide defects related to CZ-Si.

a)

b)

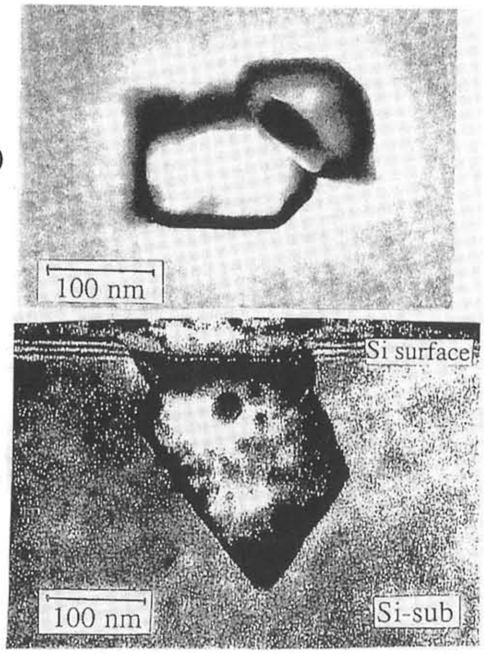

Fig. 3. Defect origin observed on the Si surface under gate-oxide defects. TEM micrograph: (a) plan view and (b) cross-sectional view

a)

b)

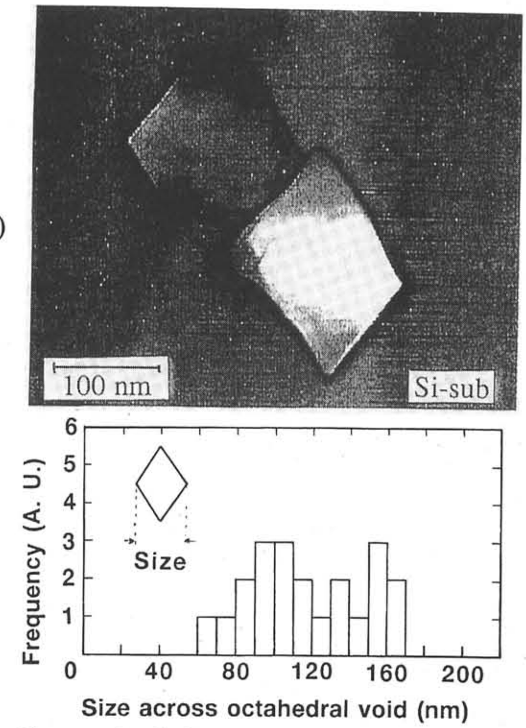

Fig. 4. Grown-in defects observed in the bulk Si. (a) TEM micrograph, cross-sectional view. (b) Size distribution

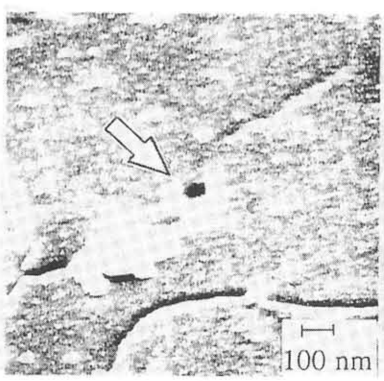

Fig. 5. SEM micrograph for poly-oxide defect origin.

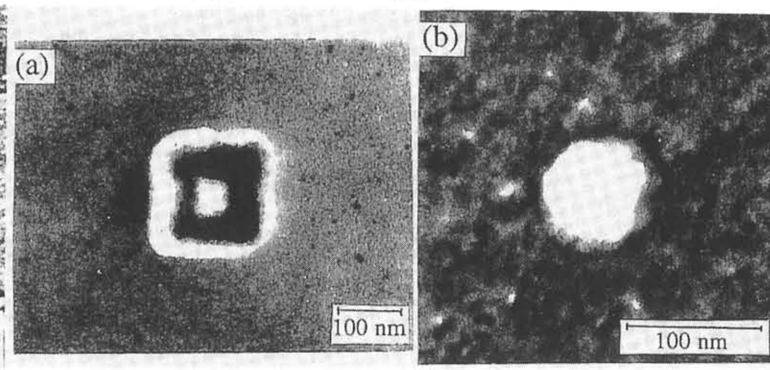

Fig. 6. TEM micrographs for buried-oxide defects of SIMOX wafers. Plan-view: (a) square (octahedron) and (b) polyhedron

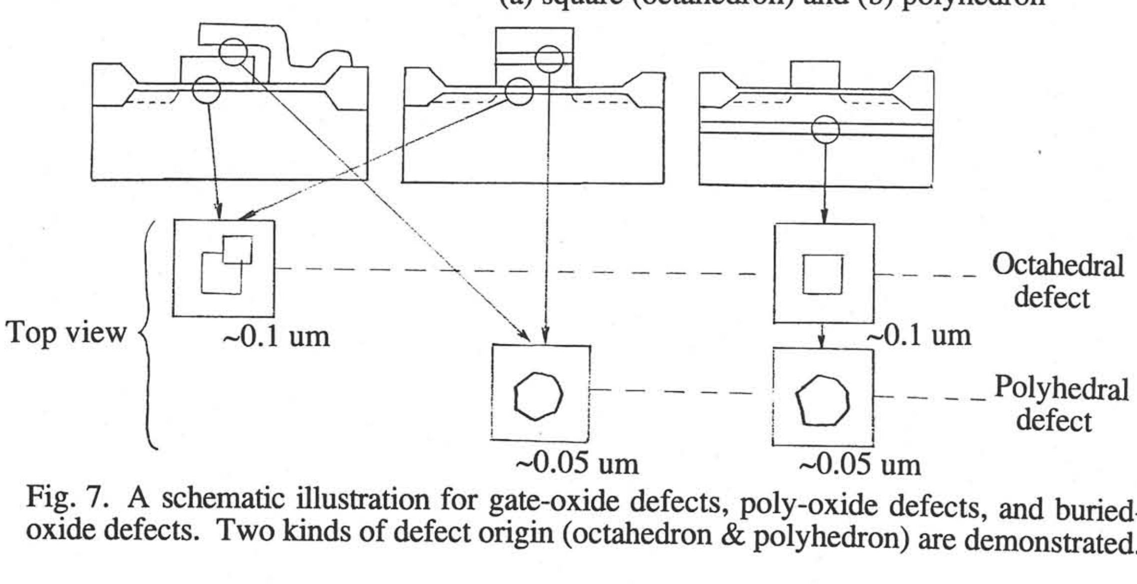

Fig. 7. A schematic illustration for gate-oxide defects, poly-oxide defects, and buried-oxide defects. Two kinds of defect origin (octahedron & polyhedron) are demonstrated.