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Study of HF Defects in Thin Bonded SOI Dependent on Original Wafers

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1.Introduction

We have been studied defects in bonded SOI wafers by using modified Secco etching method[1]. It was suggested that defects in thin bonded SOI wafers fabricated by PACE process [2] were distinguished into polishing scratches and defects related to original bulk wafers. The polishing scratches were recovered by annealing in non-oxygen ambient. COP at SOI/buried oxide (BOX) interface was one of the bulk related defects[3].

On the other hand, HF dipping is another method to detect the defects called HF defect. The dependence on original wafers was investigated by Tomita et al[4]. They showed that epitaxial wafers and hydrogen annealed wafers were effective to eliminate HF defects. It indicated the origin of HF defect was related to bulk defect. However the true character of HF defect was not recognized.

In this study, relation between HF defect and COP at SOI/BOX interface in PACE'd SOI wafer was investigated.

2.Experimental

SOI wafers were fabricated by bonding technology as shown in Fig.1. 0.4~0.5 μm thick buried oxide(BOX) layers were formed by oxidizing bond wafers prior to bonding. After bonding, SOI layers were thinned by PACE process.

HF defects were detected by optical microscope after dipping samples into HF(50%) solution.

COP density was measured by a particle counter (model : LS-6000 by Hitachi DECO).

3.Results & Discussion

To confirm the dependence of HF defect density on original wafers, CZ wafers, hydrogen annealed wafers and epitaxial wafers (epitaxial layer thickness:10μm) were used for bond wafers. SOI layers were thinned to 0.1 μm without touch polishing.

The results, as shown in Fig.2, were consistent with the report by Tomita[4]. HF defects were remarkably reduced by using hydrogen annealed (1200°C,5hr) wafer and epitaxial wafer while 7cm^{-2} of defects were detected in CZ-SOI wafer.

As shown in Fig.1, a bond wafer was oxidized before bonding. Then, the oxidized silicon interface became the bottom of SOI layer. It suggested that COP at the original wafer surface existed at the bottom of SOI layer. Moreover, It was already reported that COP density at silicon surface was increased with increasing the oxide thickness[5].

To investigate relation between HF defects and COP at the SOI/BOX interface, the base wafer and BOX were peeled off after bonding anneal. The density of COP at the SOI/BOX interface was measured by LS-6000. The results were shown in Fig.3. The density of COP was the same level as that of oxidized wafer. It indicated COP remained as it was even after bonding anneal. COP density at the SOI/BOX interface was almost same as HF defect density in CZ-SOI (Fig.2). It suggested HF defect was originated by COP at the SOI/BOX interface.

Thus, epitaxial wafer is one of the candidate to avoid COP at SOI/BOX interfaces. We confirmed COP was eliminated by using epitaxial wafers (Fig.4). It consisted with the results of HF defect dependency on original bulk wafer.

Figure 5 shows the dependence of HF defect density on SOI thickness. HF defects were observed only below 0.2μm thick SOI wafer. It increased with thinning SOI thickness. This result indicated the size of HF defects, as shown in Fig.6. HF could penetrate to BOX only the defects which were larger than SOI thickness. In Fig.5, the size of HF defects was found to be below 0.2μm. It consisted with COP size.

4.Conclusion

The origin of HF defects in thin bonded SOI wafer fabricated by PACE process was investigated. It was recognized that the origin of HF defects was COP at SOI/BOX interfaces. Thus, HF defects in a SOI layer were eliminated by using wafers without COP ; i.e. epitaxial wafers for the original bond wafer.

References

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[4] S.Tomita et al., Extened Abstructs of the 44th spring meeting of the Japan Society of Appl. Phys. 29p-G-9(1997) in Japanese.
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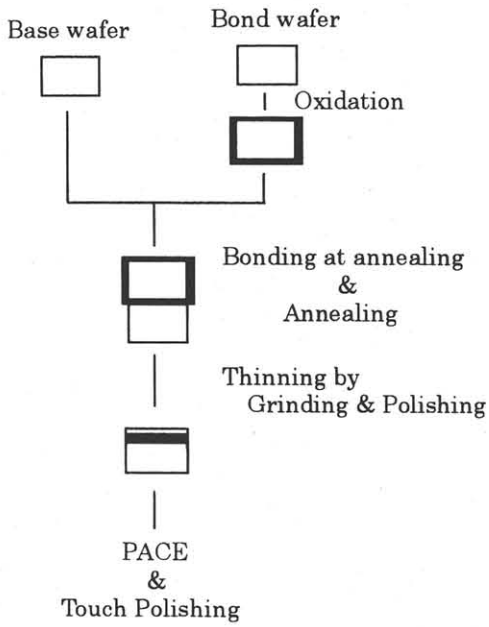

Fig.1. Fabrication process flow of PACE'd SOI wafers

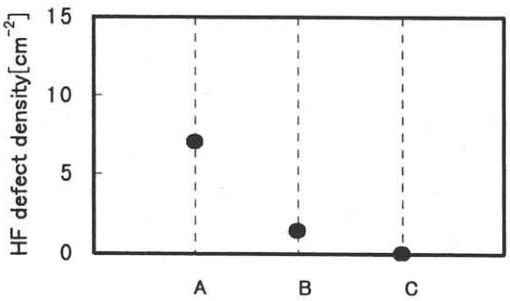

Fig.2. Dependence of HF defect density in 0.1 μm SOI on the original wafer. A... CZ-wafer, B... hydrogen annealed wafer, C... epitaxial wafer.

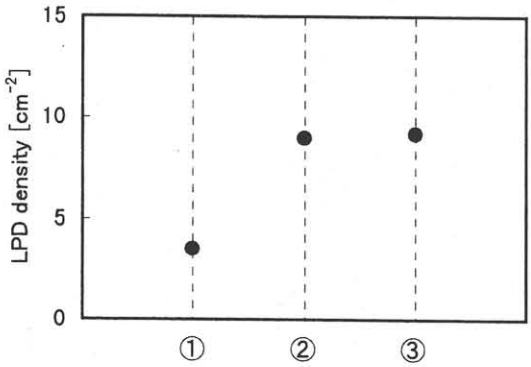

Fig.3. LPD density of CZ wafers.①reference wafer.②after oxidized③SOI/BOX interface.

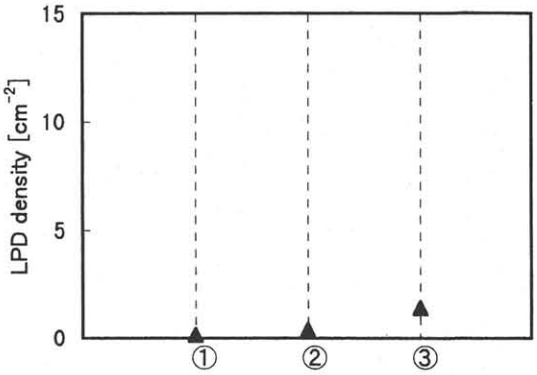

Fig.4. LPD density of epitaxial wafers.① reference wafer.②after oxidized ③SOI/BOX interface.

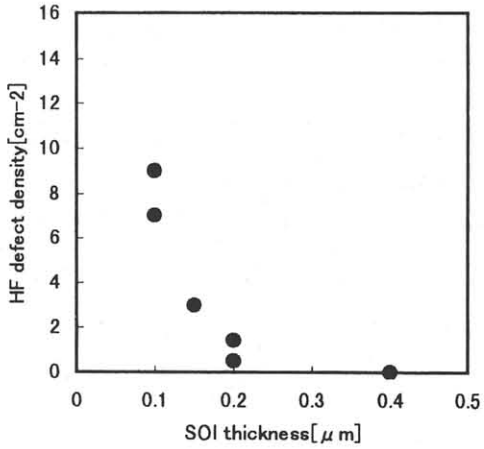

Fig.2. Dependence of HF defect density on SOI thickness.

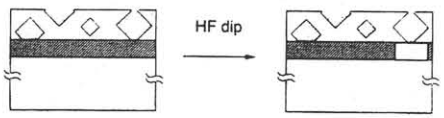

Fig.6. Schematic drawing of HF defect caused by COP