Scalable Potential and Volume Production in ELTRAN®; SOI-Epi wafers™

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Introduction

The SOI-Epi Wafer™ named ELTRAN® (Epitaxial Layer TRANsfer) by bond and etch-back method has been originated, developed and produced in Canon Inc., Japan since 1990[1-2]. For the coming device applications, the scalability that includes scaling up of the wafer diameter and scaling down of the SOI layer thickness (t_{SOI}) has been extensively developed. In particular, 300mm diametered wafer and ultra thin SOI with less than 100nm will be required according to the ITRS. In addition, the entire SOI market has been growing and also is expected to continuously grow in the future. To respond to this market enlargement, the fabrication facility for ELTRAN® has been expanded. In this paper, we discuss both scalability in ELTRAN® and our activities for mass production.

Scalable Potential[3]

300mm SOI wafer was fabricated with t_{SOI}/t_{BOX}=150nm/100nm. Reuse of seed wafers by water jet splitting technique is essential for cost reduction because 300mm seed wafers are more expensive. An as-split seed wafer (a) and the resultant SOI wafer (b) are shown in Figure 1. Uniformity of t_{SOI} is also important and critical in 300mm wafer, and is measured 147nm +/- 1.6nm. Because of high etching selectivity of 10^5 in porous Si against epitaxial Si, t_{SOI} is determined exclusively by the epitaxial layer uniformity, which is obtained by use of higher speed wafer rotation system (700rpm) in a CVD epitaxial reactor than conventional one.

Ultra thin SOI layers as thin as 30 nm were successfully formed over 200 mm ELTRAN. Inclusion defects (so-called HF defects) density (D_{INC}) in the SOI layer was measured before and after H_2 annealing in conventional vertical furnace as shown in Fig. 2. D_{INC} of ultra thin SOI film strongly depends on t_{SOI}. From this result, we found out that D_{INC} in the ultra thin SOI is decreased by H_2 annealing, which can be understood as the Si atoms migrate during the annealing and fill up small irregularities because the inclusions are enough small, which diameter was measured to be 10-30nm. After the H_2 annealing, D_{INC} is measured to be 0.250 cm^{-2} that is lower than the ITRS 2005 requirement. In addition, extremely thin film (10nm) SOI with the uniformity of +/-1.75nm was also successfully fabricated.

Volume Production[4]

Production capacity was expanded to 10K wafers per month in 2000 (8" equivalent). The manufacturing machines such as the anodizer, the bonder, the water jet splitter (shown in Fig. 3) and the porous Si etcher were exclusively designed by ourselves and all of them are fully automated and CIM systems are equipped. The other major manufacturing machines such as CVD epi reactors, furnaces and wet benches are standard machines that are used in device and Si wafer manufactures.

Primary factors in entire SOI wafer cost are starting wafers and depreciation of manufacturing equipment and facility. Recycling technology is powerful to reduce the starting material cost. We have already demonstrated the water jet splitting technology to reuse the seed wafers with very high reproductibity[5]. The large volume of production is necessary to reduce depreciation and overhead per unit product.

In order to progress the scalability and respond to its market request, 300mm ELTRAN® production line is being constructed. In which all equipments are to be fully automated as well as 200 mm production line. ISO 14001 for environmental improvements has already been granted in 1999. *Quality Assurance* systems based on ISO 9001 are planed to be certificated in 2001.

Summary

For further progression, scalability such as 300mm-diameter and ultra thin film ELTRAN® has been developed. It will quite agree with the ITRS roadmap. These two advanced ELTRAN® technologies clearly project the potential feasibility in the future SOI technology. We have been ready to shift up to the volume production stage by the continuous fab expansion including 300 mm, cost down strategies and the quality control system.

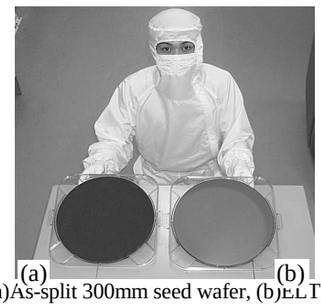

Figure 1. (a)As-split 300mm seed wafer, (b)ELTRAN® wafer

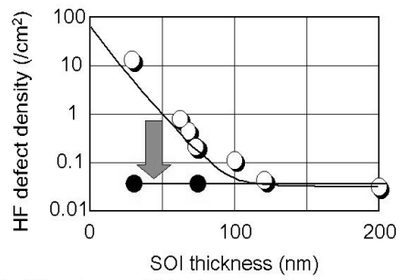

Figure 2. HF defect vs SOI thickness before (open) and after (close) hydrogen annealing.

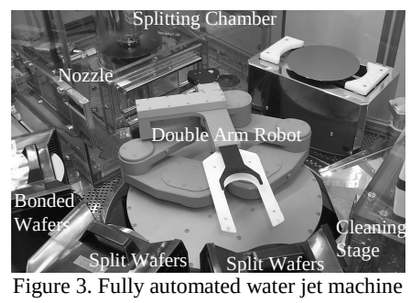

Figure 3. Fully automated water jet machine

References

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