Status Of 300 mm SOI Material; Comparisons with 200 mm

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While SOI material has recently become available for use in circuit fabrication lines, little is known at present about the quality of this new material and how it compares to the well-established 300 mm material. To remedy this, a variety of highly-developed characterization techniques have been used to use both in quality control and in material development. These techniques include spectroscopy for thickness and uniformity determination, AFM and optical inspection for surface roughness roughness, particles, HF defects, and divots, electrical techniques for determining hole and electron mobilities, fixed charge, interface starte densities, and carrier lifetimes, and techniques for measuring BOX electrical quality including leakage and early breakdown events.

Comparisons of 300 mm material from 5 different vendors shows that 300 mm SOI material is well on its way toward being a reliable and high quality substrate for circuit fabrication, but several problem areas remain, and the quality is not yet as high as 200 mm material. Some of the key issues are listed here. 1) SIMOX thickness uniformity is higher than bonded, and not as good as 200 mm material. 2) The low field electron mobility is significantly lower for bonded than for SIMOX in 300 mm material, and this difference is much greater than in 200 mm material (Figure 1). The hole mobility is also higher in SIMOX 300 mm material than bonded (Figure 2) while in 200 material, the mobilities were comparable. 3) The interface state density at the film/BOX interface is higher in bonded than in SIMOX and higher in 300 mm than 200 mm.(Figure 3). 4) The particle density is several orders of magnitude higher in 300 mm material than in 200 mm, suggesting the need for more rigorous cleaning in the new material. The HF defect density is also higher in 300 mm, in agreement with higher particle densities. 5) Both SIMOX and bonded SOI can exhibit one or more surface blemishes which include shallow and deep divots, mounds, pinholes, and embedded foreign material. These defects represent both an inspectabiliy problem and potential yield and reliability limiters. The density of these surface features has stayed relatively constant from 200 mm to 300 mm material. In SIMOX, blocked implants may be the the major cause along with particles of foreign material. In bonded, particles are one possible cause. 6) The surface roughness is comparable in both 200 mm and 300 material and higher in SIMOX than in bonded. Indications from circuit results suggest that this has no first order effect on gate oxide integrity. 7) The mini-breakdown voltages are comparable in 300 mm and 200 mm material and are higher in bonded than in SIMOX.

With 300 mm fabrication coming on line, a strong incentive exists to improve the quality of 300 mm SOI material rapidly, and it can be expected that these improvements will develop quickly.

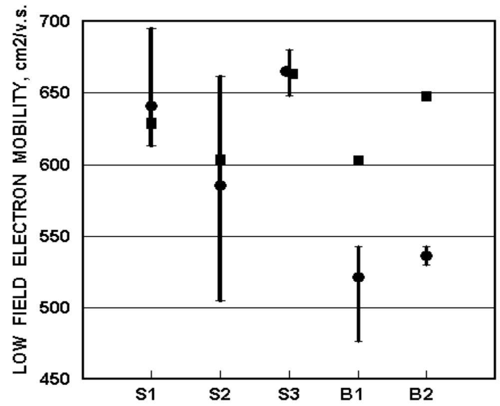

Figure 1. The low field electron mobility for SOI material with 70 nm Si films and approx. 140 nm buried oxide. The bars show the max - min limits; the circles are 300 mm averages and the squares are 200 mm averages. Si - S3 are SIMOX and B!, B2 are bonded material.

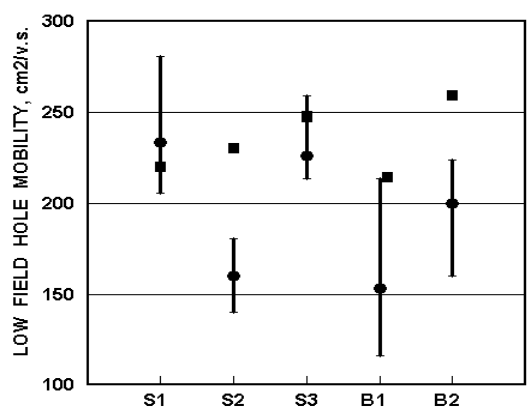

Figure 2. Low field hole mobility. Same conditions as described in figure 1.

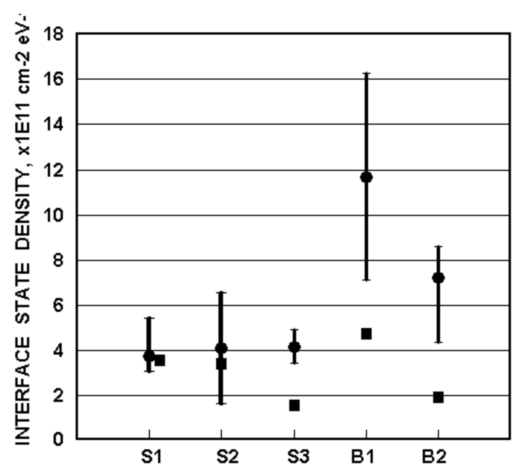

Figure 3. Interface state density at Si film / BOX interface. Same conditions as in figures 1 and 2.