ESRF	**Experiment title:** **INVESTIGATION OF CRYSTALLINE DEFECTS IN SILICON ON INSULATOR MATERIALS PRODUCED BY WAFER BONDING**	**Experiment number:** **HC 533**
Beamline: **ID 19**	**Date of experiment:** **from: 25.7.1996 to: 27.7.1996**	**Date of report** **5.8.1996**
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Report:

In microelectronics, Silicon On Insulator (SOI) technologies were essentially used in specific areas (military, space, . . .) [1]. However, the importance of these technologies increased considerably due to the “power crisis” and the boom in portable systems. In 1993 the low power, low voltage market part was only **4%** of the total integrated circuit market, but it is expected to reach 40% in 1998 (source ICE 1994) [2]. To reach this objective, high quality SOI wafers are needed. Two competitive techniques are available on the market today: the SIMOX (Silicon separated by implanted oxygen) and the wafer bonding technology. At LETI several SIMOX technologies were developed and at the ESRF very interesting X-ray topographical results have been obtained on this material (see results of experiment number HC224, and [3-6]).

Recently, at LETI, an original patented wafer bonding technology called “Smart Cut®” has been developed. This technology combines proton implantation and wafer bonding [7]. In this way it exhibits the advantages of both technologies: “Si thickness uniformity” due to the implantation process and high quality material due to the waver bonding.

In order to be attractive for ULSI applications, high crystalline quality of the upper thin silicon film has to be reached. Two kinds of effects which decrease the perfection of that upper silicon layer had to be investigated with highest priority. One are dislocations and their strain fields. The other are voids or non bonded areas, probably due to surface inhomogeneities and to the presence of particles at the surface of the two wafers just before bonding.

The first step of our investigations was to use X-ray topography at high photon energies (30 keV) and to try to visualize these defects. Due to the late date we could perform our experiments, only first results and a first interpretation may be given.

It appeared that dislocations could not yet be detected. This may be due to their non existence or to the fact that the second kind of defects, the voids or non bonded areas, provide a rather strong contrast that overlays that of the dislocations. For that reason we tried first to understand the mechanism of this contrast and its origin (which kind of deformation). Using either white beam topography or taking tomographs in a double crystal arrangement for different working points on the rocking curve, we were able to record tomographs from layer and substrate reflections. On this basis the disorientation between layers and substrates could be measured, the deformation (maximum effective misorientations) of layers and substrates could be estimated, and a first very rough model for the responsible deformation field could be derived. On this basis the measuring procedure could be optimized. The next step will be a systematic investigation of the influence of different process and sample parameters on the crystalline quality of the top silicon layer to find hints for improvements of the bonding process. After that it will be possible to look for remaining defects like the above mentioned dislocations.

References

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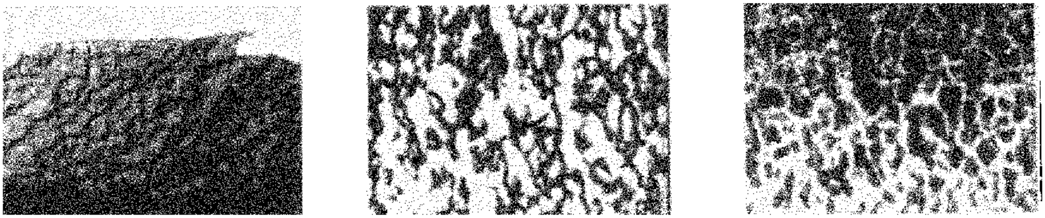

a) b) c)

Three typical tomographs of wafer bonded samples, layer thickness 15 µm (partially etched away), horizontal image widths 1.7 mm, $\lambda \approx 0.4$ Å

a) white beam topograph, 040 layer reflection,

b) double crystal topograph, 022 layer reflection at the maximum of the rocking curve,

c) double crystal topograph, 022 substrate reflection at the maximum of the rocking curve (the contrasts in b and c are partially complementary),