Low Temperature LPCVD Epitaxy of In-Situ Boron Doped SiGe and SiGeC Strained Layers with sub-E17 Oxygen Concentration

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The purpose of this work is to identify primary contributors to elevated oxygen incorporation, which occurs during low temperature LPCVD epitaxy of SiGe and SiGeC. By understanding the sources and mechanisms, in which oxygen incorporates it is possible to achieve oxygen levels that compete with those of UHVCVD. The benefits are greatly accelerated process recovery rates, improved process stability, and greater minority carrier lifetimes.

The paper will include (1) studies of various oxygen profiles encountered during processing and their cause. (2) Oxygen sources and mechanisms within a vacuum and (3) oxygen related effects on boron incorporation, sheet resistance, and minority carrier lifetime. The oxygen levels were determined by SIMS. The SiGe and SiGeC films were processed by LPCVD in an AMAT 5200 Centura platform.

Figures 1 and 2 are a few examples of oxygen profiles encountered. Other types of profiles and their causes will be discussed. **Figure 3** illustrates a typical 6-8 week time requirement for oxygen levels to stabilize below 1E18 atoms/cc following equipment rebuild.

Figures 4 and 5 illustrate that elevated oxygen will adversely affect both sheet resistance and minority carrier lifetimes. The data in figure 4 implies an in-film oxygen threshold in the vicinity of 1E18 atoms/cc. This further suggests that to achieve a margin of safety for enhanced processing, levels in the range of SIMS detection might be necessary.

Figure 6 illustrates that sub-E17 atoms/cc performance by LPCVD is possible within a week of equipment recovery.

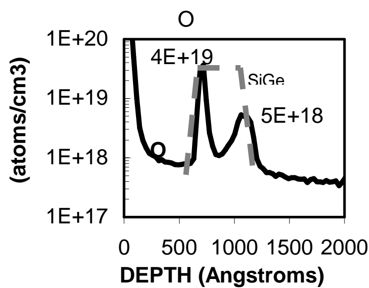

Fig. 1 Oxygen at the heterojunctions

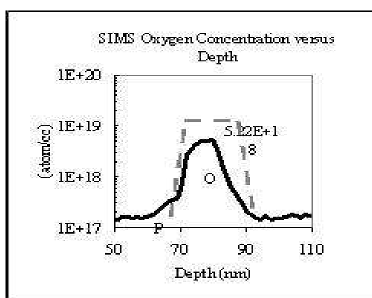

Fig. 2 Oxygen throughout the film

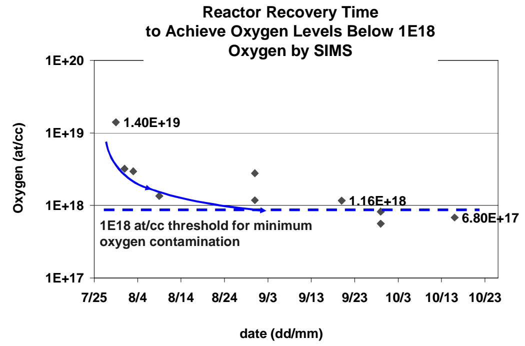

Fig. 3 6-8 week time required for sub-E18 oxygen following equipment intervention

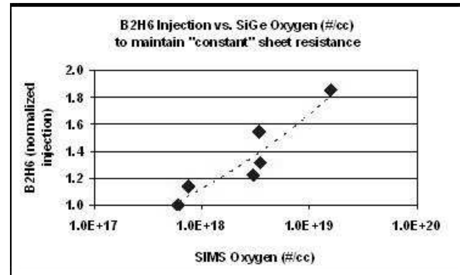

Fig. 4 B_2H_6 injection required to maintain constant sheet resistance of boron doped SiGe

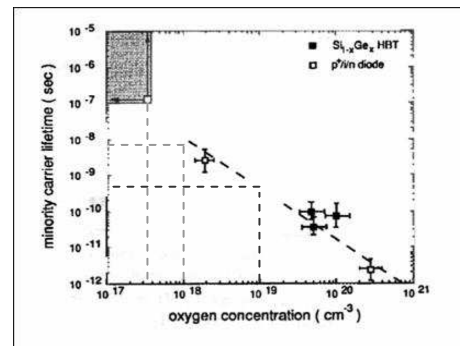

Fig. 5 Effect of oxygen on minority carrier lifetimes in 22% to 23% SiGe films [Hoyt, Kamins]

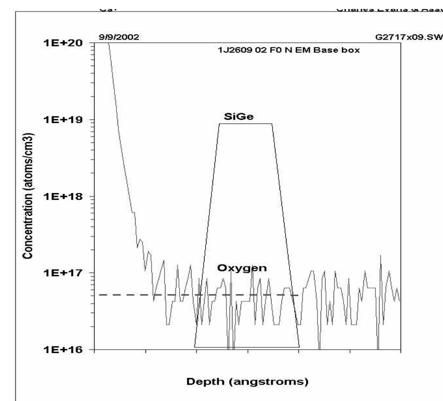

Fig. 6 Sub-E17 at/cc Oxygen by LPCVD verified within 1 week of equipment recovery