Abs. 1305, 206th Meeting, © 2004 The Electrochemical Society, Inc.

"H getter structures for improved Ge layer exfoliation processes"

Arthur J. Pitera and Eugene A. Fitzgerald
Department of Materials Science and Engineering,
Massachusetts Institute of Technology
Cambridge, MA 02139

Ge [1] and GaAs [2] transfer to Si using the layer exfoliation [3] process have been recently demonstrated by researchers. Such processing techniques can be used to fabricate structures for III-V device integration with Si as well as GOI platforms for high performance microelectronic applications. More generally, the coupling of wafer bonding and layer exfoliation provides the flexibility for monolithic integration of virtually any material [4] with Si, greatly increasing the functionality of CMOS technology.

Unfortunately, processing schemes utilizing layer exfoliation require large doses of implanted H, typically ~10^{17} H·cm^{-2} to induce layer splitting. The cost of this expensive implantation step can be lowered by reducing the dose necessary to induce layer splitting. Thermal expansion mismatch is another limitation to heterointegration by wafer bonding [5]. Although the layer exfoliation process can be used to alleviate the thermal stress arising from bonding thermally mismatched wafers, annealing temperatures must nonetheless be minimized to prevent wafer delamination.

We have recently demonstrated a process for transferal of epitaxial Ge layers to large diameter Si wafers utilizing H-ion implantation and a strained SiGe etch-stop layer [6]. The etch-stop was used to selectively remove the exfoliation damage in the Ge with a H_2O_2 etch after wafer bonding and layer transfer. In addition, we have demonstrated that strained SiGe layers grown under tensile strain also display H-gettering behavior and can be incorporated with Ge to locally enhance the H concentration in the implanted donor wafer. Figure 1 is a TEM micrograph showing such a Ge transfer structure comprised of a SiGe etch-stop and second SiGe film which serves as a H gettering layer. The micrograph shows two strain fields in the region of the implant; one surrounding the peak concentration of the as-implanted H profile and the other surrounding the getter layer. After H-ion implantation and annealing, the getter layer contains an enhanced H concentration, shown in Figure 2. This structure exhibits a significantly enhanced tendency for blister formation compared to H-implanted Ge without a getter layer.

The gettering properties of strained SiGe layers and their application to Ge layer exfoliation will be presented. Incorporation of H-getter layers greatly enhances the exfoliation kinetics of Ge, allowing a concomitant reduction of H dose and implant annealing temperature. Data will be presented showing the enhanced exfoliation kinetics of Ge structures containing H-getter layers. Also, the apparent role of vacancies and their role in localized platelet formation will be discussed.

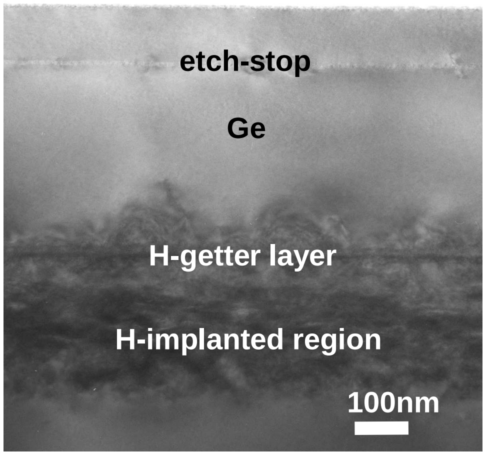

Figure 1 – XTEM micrograph showing a H$^+$-implanted getter structure after implant annealing. The etch-stop and getter layers are comprised of strained SiGe grown on a relaxed Ge donor wafer.

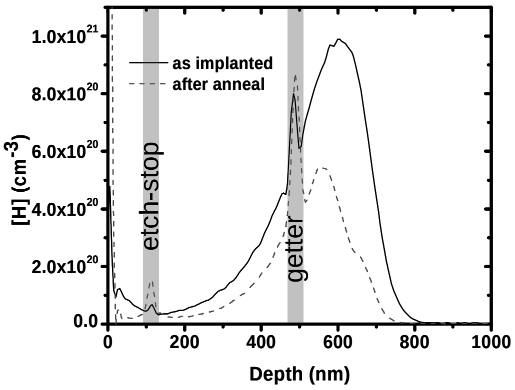

Figure 2 – SIMS profiles showing enhanced H concentration in a strained SiGe getter layer, before and after implant annealing.

References:

1. J. M. Zahler, C. -G. Ahn, S. Zaghi, H. A. Atwater, C. Chu, and P. Iles, Thin Solid Films **403-404**, 558 (2002).
2. E. Jalaguier, B. Aspar, S. Pocas, J. F. Michaud, M. Zussy, A. M. Papon, and M. Bruel, Electron. Lett. **34**, 408 (1998).
3. M. Bruel, Electron. Lett. **31**, 1201 (1995).
4. J. Haisma, B. Spierings, U. Biermann, and A. van Gorkum, Appl. Opt. **33**, 1154 (1994).
5. V. Lehmann, K. Mitani, R. Stengl, T. Mii, and U. Gösele, Jpn. J. Appl. Phys. **28**, L2141 (1989).
6. A. J. Pitera, G. Taraschi, M. L. Lee, C. W. Leitz, Z. – Y. Cheng, E. A. Fitzgerald, submitted to J. Electrochem. Soc. for publication (2003).