GaAs Layer Splitting By Helium And/Or Hydrogen Implantation

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OBJECTIVES

Monolithic integration of GaAs into silicon technology requires fabrication of high quality single-crystalline GaAs onto silicon and would result in new applications in optoelectronics, microwave electronics and high temperature electronics devices. Layer transfer by ion implantation and wafer bonding techniques is one of the most promising approaches to obtain thin single-crystal layers (including GaAs) on any substrate without any epitaxial relationship between the film and the substrate [1]. It was shown that in order to achieve blistering/splitting after a post-implantation annealing the implantation temperature must fall within a temperature window specific to each material [2]. The present paper presents our latest achievements in transferring thin single-crystalline GaAs onto Si substrates as well as the influence of the dose and implantation temperature on the formation of micro- cracks during He and/or H-implantation and their evolution at subsequent annealing.

APPROACH

In order to obtain the conditions for an optimal layer splitting blister formation in helium (He) and/or hydrogen (H)-implanted (100) GaAs was studied for different implantation conditions, i.e. implantation energies of 130- 160 keV, implantation doses ranging from $2\text{x}10^{16}$ cm^{-2} to $5\text{x}10^{16}$ cm^{-2}, and implantation temperatures from room temperature up to 300°C. Co- implantation of He followed by range matched H was also investigated. Nomarski optical microscopy, atomic force microscopy (AFM) and scanning electron microscopy (SEM) were used to check for blistering and exfoliation. Formation of platelet-like defects and their evolution after annealing were analyzed by cross-section transmission electron microscopy (XTEM).

RESULTS

Optimum conditions for blistering/splitting of He and/or H-implanted GaAs were obtained. Under certain implantation conditions it was found that after post-implantation annealing large area exfoliation instead of blistering occurs. This effect is directly related to a narrow depth distribution of the platelets in as-implanted GaAs and their evolution during annealing. Successful transfer of single-crystalline GaAs on Si was achieved by room- temperature bonding of as-implanted GaAs to a Si wafer via a spin-on glass (SOG) film and subsequent annealing. XTEM investigation shows a high quality bonding interface between GaAs and SOG/Si wafers.

CONCLUSIONS

We show that a GaAs layer splitting approach by He and/or H implantation and wafer bonding can be successfully used for transferring of GaAs films on silicon substrates.

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REFERENCES

1. M.Bruel, B. Aspar, B. Charlet, C. Maleville, T. Poumeyrol, A. Soubie, A. J. Auberton-Herve, J. M. Lamure, T. Barge, F. Metral and S. Trucchi, IEEE International SOI Proceedings, 178 (1995).
2. Q. -Y. Tong and U. Gösele, Adv. Mat. **11**, 1404 (1999).