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Ion-cutting of GaSb Wafers by H or He Implant

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INTRODUCTION

GaSb is an important substrate material in the application of high speed electronic and long wavelength photonic devices [1]. Its lattice parameter matches various ternary and quaternary III-V semiconductors whose band gaps range widely from ~0.3 to 1.58 eV [2]. GaSb based structures are of potential interest in the fabrication of microwave devices. For instance, InGaSb has been proposed as an ideal material for transferred-electron devices [3]. In such a device, a semi-insulating substrate lattice-matched to InGaSb is required. GaSb seems to be the obvious choice. However, semi-insulating GaSb wafers are currently not available. One way to solve this problem is to grow a thin layer of GaSb on a semi-insulating substrate, e.g. GaAs. However, in this process, lattice mismatch has an influence on the quality of the grown GaSb layer. An alternative way is to transfer a thin layer of GaSb onto an insulator using Ion-cutting. In this technique, H and/or He ions are implanted in a GaSb wafer with a dose of a few times 10^{16} cm^{-2}, followed by bonding to a stiffening wafer coated with an insulator. Upon appropriate annealing, a thin layer of GaSb is transferred onto the insulator, thus serving as a template for further growth of semiconductor layers, e.g. InGaSb.

RESULTS

In this study, n-type (100) GaSb wafers, Te doped with a dopant level of 7×10^{17} cm^{-3}, were implanted with 150 keV H or He ions at various doses. We found that blistering occurred readily in both H and He implanted samples. The surface bubbles showed a tendency to coalesce to form large areas of exfoliation. This can be clearly seen in samples annealed faced down on a smooth substrate, where an entire surface layer was exfoliated from the GaSb substrate, in marked contrast to the blistering phenomenon of hydrogen-implanted silicon wafers.

The tendency of the H- and He- implants in GaSb to form large-area exfoliation without bonding indicates a less stringent requirement on the bonding strength between GaSb and the stiffening wafer. However, low temperature hydrophilic bonding (typically < 400°C) of GaSb to other substrates proved to be difficult, due to the poor wafer surface quality and the difficulties in providing hydrophilic surfaces. Our preliminary results showed that the bonding of GaSb wafers could be facilitated by an appropriate bonding medium. The transfer of GaSb surface layer onto an insulator was demonstrated for the first time by using flowable oxide as the bonding medium. For samples implanted with 150 keV He ions, 5um × 5um AFM scans over the transferred GaSb layer showed a RMS value of about 25 nm. Possible ways of improving bonding quality will be discussed.

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