ION-CUTTING OF SiC AND Si: THE USE OF CHANNELED-ION IMPLANTATION AND OTHER IRRADIATION TECHNIQUES FOR PROCESS OPTIMIZATION (INVITED)

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Ion-cutting, a method for forming heterostructures, depends critically upon various processes including gaseous-ion implantation to delineate and separate a surface layer from its bulk source, and hydrophilic bonding of the source to a target wafer to effect the transfer of the layer. Hydrogen-ion implantation has been used quite successfully in this transfer process especially in forming silicon-on-insulator. However, a standard implantation scheme commonly used for introducing hydrogen into the lattice is shown to be an inefficient method for effecting separation and does not yield the highest quality material. Rather a judicious choice of implantation parameters or conditions is shown to have rather dramatic effects upon the process. In particular, it will be demonstrated that implantation of hydrogen into 6H- or 4H-SiC, as well as Si, by channeling along a major axis in the crystal (rather than a random direction) offers substantial benefits. These include a less-defective transferred layer, an important issue in forming SiC heterostructures. Surprisingly, channeled-ion implantation was found to promote film transfer at a lower fluence than a random implant. A study of this phenomenon has yielded a much better understanding of the behavior of implanted hydrogen in the studied materials. This, in turn, has yielded insight into the effects of the various implant parameters upon the ion-cutting process so that they can be tailored for optimal efficiency. This will be discussed as well as various optimization schemes derived from these results. This study was directed by observation of exfoliation in implanted wafers, a process closely related to that responsible for ion-induced separation of bonded pairs.

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