Role of implanted species on thermal evolution of ion-induced defects in ZnO

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ZnO is a direct and wide band gap semiconductor that has received a tremendous research interest due to its remarkable properties and potential technological applications in optoelectronics, spintronics, etc. [1]. Despite that ion implantation can be efficiently used to introduce electrical, optical or magnetic active impurities, poor understanding and control of ion-induced defects hinders device processing in ZnO.

Here we present a comprehensive and systematic investigation of the influence of the ion species (ranging from ^{11}B to ^{209}Bi) on the thermal stability of ion-induced defects in wurtzite ZnO samples implanted to relatively high ion doses. The structural defects were characterized by a combination of RBS/C and XTEM, while dopant diffusion and behavior of intrinsic impurities were monitored by SIMS. It is demonstrated that the thermal evolution of ion-induced defects strongly depends on implantation conditions such as the density of collision cascades, implantation dose and ion species. In particular, depending on ion mass, the defect evolution exhibits a single (light and medium mass ions) or two-stage (heavy ions) annealing behavior with increasing temperature. Furthermore, the effects of the implanted species (dopants) may lead to a nontrivial defect evolution during the annealing, with F, N, Ag and Er as prime examples [2], which is attributed to the formation of different dopant-defect complexes, their thermal stability and diffusivity. In addition, it is demonstrated that the behavior of group-Ia residual impurities, such as Li, during post-implant annealing can be efficiently used for identification of the preferential sublattice localization of implanted atoms and the evolution of self-interstitials [3].

References

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