2000 MRS Fall Meeting
Symposium R, Microstructural Processes in Irradiated Materials

Invited Paper: I was invited by G. E. Lucas

DOPANT IMPLANTATION AND ACTIVATION IN SiC

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Activation of implanted dopants in SiC will be discussed. Conventional wisdom states that the best electrical results (i.e., carrier concentrations and mobility) are achieved by processing at the highest possible temperatures. This includes implantation at >600°C followed by furnace annealing at temperatures as high as 1750°C. Despite such aggressive and extreme processing, implantation suffers because of poor dopant activation, typically ranging between <2%–50% with p-type dopants represented in the lower portion of this range and n-types in the upper. Additionally, high-temperature processing can led to several problems including changes in the stoichiometry and topography of the surface, as well as degradation of the electrical properties of devices (i.e., channel mobility and gate oxide integrity). Two approaches for resolving these problems in 4H-SiC will be discussed. The first consists of a traditional implantation scheme optimized over a wider range of parameters than normally studied. In particular, dynamic effects within the SiC lattice require that temperature and dose-rate be treated complimentary and, thus, optimized conjointly. Results of this study will be presented. Secondly, a more novel approach for increasing activation of implanted dopants in SiC and lowering the activation temperature will be discussed. This approach utilizes the manipulation of the ion-induced damage to enhance activation of implanted dopants. It will be shown that nearly amorphous layers containing a small amount of residual crystallinity (<10% by volume) can be recrystallized at temperatures below 900°C with little residual damage. It will be shown that recrystallization traps a high fraction, ~90%, of the implanted dopant residing within the amorphous phase (prior to annealing) onto substitutional sites within the SiC lattice.

Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Dept. of Energy under contract DE-AC05-00OR22725.

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