INVITED ABSTRACT– Spring 2002 MRS Meeting
Symposium F– Defect and Impurity Engineered Semiconductors and Devices III

VACANCY IMPLANTATION—NO LONGER JUST A MYTH, T. E. Haynes, R. Kalyanaraman, and O. W. Holland, Oak Ridge National Laboratory, Oak Ridge, TN; H.-J. Gossmann, D. C. Jacobson, and C. S. Rafferty, Agere Systems, Murray Hill, NJ.

In spite of the fact that interstitials and vacancies are produced in equal numbers (as Frenkel pairs or FPs) during ion implantation, it is well known in silicon that the interstitial-type defects overwhelmingly dominate the evolution of the system after implantation. The mutual annihilation of vacancies and interstitials arising from the FPs can be nearly perfect, but each implanted atom itself adds an extra atom (interstitial) to the system as described by the so-called "plus-one" model. Consequently, such phenomena as enhanced diffusion, electrical activation, and dislocation growth and dissolution, etc., can be described quantitatively by considering only the interstitial interactions. This situation has made the properties of interstitial-type defects relatively easy to detect and measure and provided a useful tool for interstitial-based defect engineering. However, truly effective defect engineering requires a more complete understanding that includes knowledge of the behavior of vacancy-type defects and independent control of the vacancy concentration. There is a real need for a "vacancy implanter" in our defect-engineering toolkit.

We have recently shown that MeV implantation can be used in combination with spatial separation between the vacancies and recoils to produce well-controlled vacancy supersaturations. This presentation will review recent experiments based on this concept of a vacancy implanter. These experiments have revealed the properties of vacancy-rich environments in silicon such as the energetics and kinetics of vacancy clustering and cluster dissolution. In addition, new effects resulting from implantation through interfaces and in channeling directions have been discovered. This presentation will discuss significant technological implications of these results for dopant activation and strain engineering.

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