Diffusion and defect reactions in semiconductors

The transport of matter in solids and the interaction of point defects are fundamental processes that affect the diffusion and electrical activation of dopants in semiconductors. The diffusion of dopant atoms in elemental semiconductors is generally mediated by vacancies and self-interstitials. In compound semiconductors, native point defects on both sub-lattices can contribute in diffusion. It is the ultimate scope of dopant diffusion studies to characterize not only the type of point defects involved in the diffusion process but also to identify the underlying mechanisms of dopant-defect interactions.

In this presentation I will report experiments on diffusion in elemental and compound semiconductors. Diffusion profiles of self- and dopant atoms are analyzed by means of secondary ion mass spectrometry (SIMS). Compared to SIMS that yields information about the chemical concentration of an element, the spreading resistance technique and scanning spreading resistance microscopy (SSRM) are applied to probe the distribution of electrically active defects. Both techniques complement each other perfectly, as important information on the deactivation of dopant atoms can be derived from the comparison between the chemical and electrically active diffusion profile. This is demonstrated exemplary for arsenic in germanium whose electrical activation is strongly limited by the formation of dopant-defect clusters. In order to identify the diffusion and electrical behavior of dopants in semiconductors, techniques should therefore be combined that can provide information on the chemical and the electrically active dopant concentration.