Contribution ID: **10** Type: **not specified**

Uncovering new diffusion phenomena in compound semiconductors

Friday, 20 November 2009 10:10 (20 minutes)

It has been shown that the presence of an external Cd pressure effects the formation of so-called uphill diffusion profiles in CdTe around 800 K. This surprising diffusion behavior has meanwhile been demonstrated for the elements Ag, Cu, Au, and Na in radiotracer experiments using suited isotopes delivered by ISOLDE [1,2,3]. It has also turned out that uphill diffusion can also be initialized, but at significantly lower temperatures, by different metal layers evaporated onto the surface implanted with the respective radiotracer. Besides for the group I dopants mentioned above, also for 61Co an unusual diffusion behavior is observed at diffusion temperatures up to 850 K, which converts to normal diffusion at a temperature of 900 K.
The diffusion of impurities like Ag in CdTe performed by annealing at 828 K under Cd pressure leads to symmetrically and peak-shaped depth profiles with respect to the center of a 800 µm thick crystal. The formation of such a profile requires that Ag atoms have diffused from regions of low concentration to regions of higher concentration, what is contrary to what is usually expected in diffusion experiments. Simulations of the diffusion profiles, which reproduce the experimental data in a quantitative way by taking into account the charge state and drift of the different defects, yield the following information: The dopant atoms are dominantly present as positively charged interstitials. They convert the initially Cd-vacancy rich, p-type material, into n-type material. As a consequence, the dopant profile maps the position of the Fermi level across the depth of the crystal, reflects at the same time the profile of the intrinsic defects, and the positions of the steep gradients of the concentration profile correspond to the positions of pn junctions in the semiconductor [4,5].
Recent experiments show if a thin metal layer is evaporated onto the implanted surface before the diffusion step uphill diffusion is observed as well: Thus, at a diffusion temperatures of 550 K (30 min) the presence of a Cu layer (20 nm) effects that the implanted Ag atoms are moved in a quantitative way to the backside of a 700 µm thick CdTe crystal if the crystal used has initially Te excess. In contrast, this effect is not visible if the evaporated metal layer is absent. Uphill diffusion of Ag is also observed if Cu is replaced by layers consisting of Au, Ni or Al.
It seems to be a general finding that uphill diffusion in CdTe is observable under the condition that the crystal lattice exhibits Te excess and and a source generating interstitial Cd defects is provided during the diffusion process. Such a source of the interstitial Cd defects can either be formed by an external Cd vapor or by a Cd layer formed at the interface between the CdTe crystal and an evaporated metallic layer that extracts the Te atoms. Thus, the quantitative differences observed for the different metal layers might be related to a different efficiency in extracting Te atoms at the interface out of the CdTe lattice.

[1] H. Wolf, F. Wagner, Th. Wichert and ISOLDE Collaboration, Phys. Rev. Lett. 94 (2005) 125901
[2] H. Wolf, F. Wagner, T Wichert, Defect and Diffusion Forum 237-240 (2005) 491.
[3] H. Wolf, F. Wagner, J. Kronenberg, Th. Wichert, and ISOLDE collaboration, Defect and Diffusion Forum 289-292 (2009) 587.
[4] H. Wolf, F. Wagner, Th. Wichert, R. Grill and E. Belas, J. Electr. Mat. 35 (2006) 1350
[5] H. Wolf, F. Wagner, J. Kronenberg, Th. Wichert, R. Grill, E. Belas, and The ISOLDE collaboration, Diffusion Fundamentals 8 (2008) 3.1-3.8.

Primary author: WICHERT, Thomas (Technische Physik, Universität des Saarlandes)

Co-authors: Dr WAGNER, Frank (Technische Physik, Universität des Saarlandes); Dr WOLF, Herbert (Technische Physik, Universität des Saarlandes); Mr CIESLAK, Janko (Technische Physik, Universität des Saarlandes); Mr KRONENBERG, Jörg (Technische Physik, Universität des Saarlandes); Mr JOHNSTON, Karl (Technische Physik, Universität des Saarlandes); Dr DEICHER, Manfred (Technische Physik, Universität des Saarlandes)

Presenter: WICHERT, Thomas (Technische Physik, Universität des Saarlandes)

Session Classification: Session 9: Solid State Physics I