Comparison of Background Donor Concentration in HgCdTe Grown with Different Technologies

Bonchyk O.Yu.[1], Mohylyak I.A.[1], Savytskyy H.V.[1], Fitsych O.I.[2],
Voitsekhovsky A.V.[3], Izhnin I.I.[4]

[1] Pidstrygach Institute for Applied Problem of Mechanics and Mathematics, Lviv, Ukraine
[2] Army Academy named after Hetman Petro Sahaydachnyi, Lviv, Ukraine
[3] National Research Tomsk State University, Tomsk, Russia
[4] Scientific Research Company "Carat", Lviv, Ukraine

Background donor concentration (BDC) is the important parameter for HgCdTe (MCT) because all types of MCT–based photodetectors use some kind of *n*–type material, including photoconductors, photodiodes, and most recently, nBn detectors. As a background donor concentration, we understand a total concentration of residual donor dopants (N_{RD}) and intrinsic donor defects (N_{ID}). The problem with establishing BDC in MCT, relates to the fact that detection limits of many popular physical and chemical methods are much higher than doping levels of practical interest. To determine BDC in *p*–type material one needs to convert it into *n*–type and to bring to the minimum the level of electrical compensation. For *n*–type material, maximum reduction of the level of compensation is needed.

The unique method of BDC determination in HgCdTe is the using of ion milling (IM). At IM, the crystal is supersaturated with mercury interstitial, which during the diffusion completely annihilates mercury vacancies (intrinsic acceptors), and forms a donor complexes and centers with all the most known acceptor impurities in MCT (As, Sb, Cu, Ag, Au, etc.). After the finishing of IM, these complexes decompose even at room temperature, and after relaxation, the electron concentration adequately reflects the background donor concentration.

The proposed methodology was used to study the BDC in HgCdTe epitaxial films grown by different methods: molecular beam epitaxy (MBE), liquid phase epitaxy (LPE), Metal-Organic Chemical Vapour Deposition (MOCVD) in various research centers. It is shown that the lowest BDC (level

$(2\text{-}4)\cdot10^{14}$ cm^{-3}) was observed for MBE films grown on Si substrates (Rzhanov Institute of Semiconductor Physics, Siberian Branch of RAS) and LPE films (JSC Research and Design Institute of Rare Materials Industry «GIREDMET»). Films grown with MOCVD (VIGO System SA) and with MBE (from various manufacturers) on GaAs substrates showed significantly higher BDC of the order of $\sim(2\text{-}4)\cdot10^{15}$ cm^{-3}. The possible reasons for the observed features are discussed.

In general, the studies showed the effectiveness of ion milling as a method of reducing electrical compensation in *n*–type MCT and an excellent tool for studying BDC, especially for samples extrinsically doped with acceptor dopants.