Functional Materials 10, No.2 (2003)

Preparation of semi-insulating CdTe doped with Sn

I.Turkevych, R.Grill, J.Franc, P.Hoschl, E.Belas, P.Moravec

Institute of Physics, Charles University, Ke Karlovu 5,
Prague 2, CZ-121 16, Czech Republic

Received December 2, 2002

Thermodynamic conditions for post-growth annealing to prepare nearly stoichiometric semi-insulating CdTe with a minimized concentration of point defects are studied for undoped and Sn-doped single crystals. The high-temperature (200 to 1000 °C) *in-situ* conductivity and Hall effect measurements were used to control the native defect density and to find out the cadmium overpressure at which shallow defects are compensated. It is shown that, in contrast to the undoped samples where the change of the conductivity type by variations of Cd pressure is easy to realize, the Sn- and Ge-doped samples exhibit a much more stable behavior due to the Sn self-compensation. The temperature near 500 °C is reported to be optimum for the real-time annealing of bulk samples.

Термодинамические условия послеростового отжига для получения полуизолирующего CdTe с минимизированным содержанием точечных дефектов и отклонением от стехиометрии изучены в нелегированных и легированных Sn монокристаллах CdTe. Измерения проводимости и эффекта Холла проведены в широкой области температур (200–1000°C) для исследования структуры точечных дефектов и определения давления Cd, при котором происходит компенсация мелких уровней. Показано, что, в отличие от нелегированных образцов, в которых изменение типа проводимости с изменением давления Cd происходит легко, легированные Sn образцы характеризуются более стабильным поведением вследствие самокомпенсации Sn. Показано, что оптимальной температурой для управления отжигом кристаллических образцов является 500°C.

Semi-insulating (SI) CdTe is a promising material for application as g and X-ray detector in medical imaging [1], environmental monitoring [2] and nuclear science [3]. To prepare such a semi-insulating (SI) material, the concentration of free carriers must be reduced to a level of about 10^7 cm^{-3}. In view of the fact that this concentration is much less than the impurity density in CdTe being synthesized typically from 6N or 7N purity elements, the straightforward preparation of SI stoichiometric CdTe with the state-of-the-art technological procedures is impossible.

The pinning of the Fermi level to some deep level near the bandgap middle is useful to obtain SI CdTe. If one of the native defects creates such a deep level, then this goal can be attained by deviation of stoichiometry. There is a wide discussion in the literature about the existence and dominant role of the native defects in creating deep levels in CdTe [4–6], but the possibility of undoped SI CdTe preparation is still an open to discussion.

Doping with impurities having energy levels near the midgap or forming complexes with native defects creating deep levels is a possibility to obtain SI material. Previously, the preparation of SI CdTe doped with Ge and Sn, which create the deep donor levels, was reported [7]. However, a high resistivity was obtained with high density of doping defects, which resulted in a high concentration of trapping and recombination centers and, therefore,