INFLUENCE OF LATTICE DEFECTS AND SOME IMPURITIES ON THE LUMINESCENCE OF ZnTe BETWEEN 5160 Å AND 7400 Å

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Abstract

Zinc telluride has been grown from Te-rich solutions, then annealed under controlled Zn-pressure. The material was either undoped or doped with impurities of groups I (Li, Cu, Ag), V (P), III (Al) or VII (F, Cl, Br). Photoluminescence spectra and cathodoluminescence efficiencies are given between 4°K and 300°K, and their variations with VZn and O-content determined. Implanted Cl is compared with Cl at growth. The nature of the defects and the mechanisms of emission are discussed in some cases.

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Introduction

ZnTe, a material easily crystallized, having a band structure allowing direct transitions in the red-to-green range, appears as an interesting material for electroluminescence. The fact that the material in thermal equilibrium is always p-type, because the introduction of donors leads to self-compensation, is not a decisive difficulty: not only MIS structures (1) and diffused diodes (2) have been prepared, but true p-n junctions may be obtained by ion implantation (3)(4). In these devices, minority carriers are injected from a superficial layer into the bulk material, so that the detailed nature of the luminescent centers in this bulk ZnTe is of primary importance for the device.

Therefore we have undertaken a systematic study of the luminescence due to native defects and impurities in ZnTe. In this paper we shall compare the behaviour of impurities of groups I and V, and of groups III and VII, and study the influence of oxygen and native defects. The aim of the study is to know which dopants allow a high luminescence efficiency at room temperature, and which impurities should be avoided.

The dopants were introduced either directly during single crystal growth or by diffusion. All the impurity concentrations were evaluated by mass-spectrometry except for P and Cu. Photoluminescence spectra and efficiency of cathodoluminescence (total spectrum between 5160 Å and 7400 Å) were measured.

Native defects

We have studied undoped materials in which the impurity content was of the order of or lower than 10^17 cm^-3. ZnTe was grown from liquid Zn-Te solutions of different concentrations with a modified Bridgman method (5) and annealed under various vapour pressures. According to the value of the departure from stoichiometry, two types of photoluminescence spectra may be obtained. For materials grown from solutions containing 49 to 60% Te, one observes two main transitions (Fig.1(a) : at 2.375 eV, due to an exciton (probably bound to the Zn vacancy) and at 2.237 eV, due to free electrons recombining on the second level of the Zn vacancy (5). The spectrum shown on Fig.1b, for materials grown from solutions containing 60 to 80% Te, involves a