1. Introduction

Gallium arsenide (GaAs) is one of the most frequently used compound semiconductors. Owing to its electronic properties – direct band gap and very high electron mobility – GaAs has founds broad application in production of opto- and microelectronics devices. Microwave devices require high purity quasi-undoped semi-insulating (SI) wafers, whereas optoelectronic devices require semiconducting (SC) n-type (usually Si-doped) substrates. However, despite the attractive properties, GaAs has lost a significant part of the semiconductor market in the last years. The main reasons for this are high operational costs of crystal growth and not high enough quality of GaAs single crystals. These disadvantages are in turn caused by the complexity of the GaAs system, which includes a much larger variety of point defects and defect complexes compared to elemental semiconductors, such as Si. It is known, that point defects may occur in different charge states, interacting with each other via their influence on the position of the Fermi level. However, exact interaction mechanism is still controversial. It was the goal of the present work to contribute to the improvement of this situation.

The choice of material under investigation in this work was dictated by the technological interest. As-grown n-type and semi-insulating GaAs crystals were studied. Positron annihilation lifetime spectroscopy (PALS) was used as the main method of investigation. PALS is a sensitive tool for the detection of vacancy-like defects. However, it would be hardly possible to interpret the results of positron annihilation without application of other experimental methods.

The work has the following structure: in section 2, the theoretical aspects of point defect formation important for further discussion are presented. Section 3 gives a brief review of experimental techniques, which have been used here. Section 4 is devoted to the study of as grown Si-doped GaAs. In section 5, the formation of point defects in n-type and SI GaAs at elevated temperatures is compared. The results of investigations on a variety of GaAs crystals grown by modified LEC-techniques are discussed in section 6. Section 7 deals with the interpretation of temperature-dependent positron annihilation measurements. A summary is given in section 8.