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STUDY OF THE PROPERTIES OF SEMICONDUCTOR MATERIALS USING THE METHOD OF NUCLEAR GAMMA RESONANCE SPECTROSCOPY

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Abstract:

The state of the compound iron atoms inserted into the semiconductor is dependent on the kind of conductivity and the placement of the compound atoms in the surface layer or in the material, according to the data obtained using the nuclear gamma resonance spectroscopy method.

Keywords: Energy state, Resonance, gamma, semiconductor compound atoms, surface, spectroscopy, spectra, isotope, isomer shift.

INTRODUCTION.

The characteristics of iron atoms integrated into semiconductor materials as compounds have been studied in numerous investigations. [1,2] In particular, the compound iron atoms incorporated into the most studied and most widely used GaAs semiconductor material form two deep-seated energy layers in the form of E_v+0.37эв and E_v+0,52эв in this semiconductor forbidden zone. However, it is currently unclear whether these energy levels correlate to the isolated state of the mixture's atoms or the complex in the form of a "mixture-mixture." Separate states at both the surface and the material volume have also been discovered in the post-diffusion concentration distribution of compound iron atoms in semiconductor GaAs [3]. The fact that the mixture is in a distinct state on the surface and in the volume of the material is used to evaluate the complicated distribution of the atoms in such a mixture.

The F_e atoms have a cubic state in the volumetric section of the semiconductor GaAs, which can be considered a separate isolated state [4]. The energy levels generated in GaAs' forbidden zone are likewise thought to belong to solitary atoms. The F_e atoms on the surface of the semiconductor GaAs create a complex with the vacancies around them, and distinct layers in the forbidden zone are required for them!

A charge change occurs for the F_e atoms that stay on the surface and in the volume of the semiconductor GaAs, and this process is dependent on the state of the Fermi surface.

The characteristics of YaGR spectra are known to be dependent on the symmetry and electron structure of the distribution of compound atoms in semiconductor crystals when using nuclear gamma resonance spectroscopy. The application of nuclear gamma resonance spectroscopy's emission variant allows for the measurement of the surface area and volume of a mixture of Ge atoms in a material [5].

METHODS OF EXPERIMENTS.

$P=1.6\cdot10^{18}см^{-3}$ semiconductors with the addition of $P=1.6\cdot10^{18}см^{-3}$ and Tellurium mixture were used as the starting material based on the addition of R- and P- type zinc mixtures of GaAs.

Because the mixing coefficient of the Ge atoms of the compound put into the GaAs semiconductor was not particularly high ($\sim10^{17}ат\cdot см^{-3}$, $T=1050^0C$), the emission form of this method was utilized to acquire the spectra of nuclear gamma resonance spectroscopy. Because the F_e Co^{57} energy level is created as a result of the decay reaction, the SoCo^{57} isotope was added to the GaAs under investigation. As a result, information on the F_e atoms of the molecule can be obtained by studying the charged state of the SoCo^{57} isotope.

THE RESULTS OBTAINED.

The YaGRS spectra recorded at the surface layer for SoCo^{57} (F_eCo^{57}) atoms electrolytically injected into GaAs were discovered to be dependent on the semiconductor's conductivity type in our experiment. For compound atoms on the surface of P-type materials, the YaGRS spectrum is a single (single) extended line, whereas for R-type materials, it is a quadrupol doublet.

The results of the experiment are given in the following table:

Types of materials	*Material size Fe*		*The Fe atom on the surface*	
	δ	*ΔE*	*δ*	*ΔE*
П=1.6·1018см-3	*0,632*	*0,10*	*0,602*	*0,15*
$P=1.6\cdot10^{18}см^{-3}$	*0,381*	*0,10*	*0,445*	*0,91*

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150 mk from the surface of the semiconductor GaAs. The YaGRS spectra obtained after the removal of the thickness layer changed. Although the spectra consisted of a single (single) line for both P- and R-type semiconductors, it was found that their isomeric displacement was different.

CONCLUSIONS.

Based on the results obtained, the atoms of the iron mixture in the volume of the semiconductor GaAs have a cubic structure, which can be considered as isolated atoms, and the energy levels formed in the forbidden zone can be considered as belonging to these iron atoms. In the surface layer, iron atoms combine with the vacancies present in the structure to form a complex, which also forms energy levels. Such energy levels have been shown to be relevant for iron atoms by the IR spectroscopy method in the case of GaAs located in the surface layer [5]. For iron atoms in the GaAs volume and iron atoms in the surface layer, charge changes were found to occur depending on the Fermi level state. Changes in the isomeric displacement values of the YaGRS spectra also occur due to charge changes. This is because the electron density in the Fe^{57} core changes, and this is caused by a change in the charge distribution in the 3d shell.

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