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Effect of External Actions on Characteristics of Gallium Arsenide Schottky-Barrier Diode Structures

A. B. Kamalov

Integrated Institute of Natural Sciences KKO AN RUz, Nukus, Uzbekistan

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Abstract—In this paper we analyze briefly literary information about an effect of external actions on electrophysical characteristics of gallium arsenide Schottky-barrier diode structures and their stability to external influences. We discussed radiation changes of gallium arsenide Schottky-barrier diode structures, and also we discuss effects of small radiation dose treatment.

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INTRODUCTION

Development of semiconductor super-high frequency (SHF) electronics and integrated circuits applying Schottky-barrier devices based on A^3B^5 structures is one of the reasons of studying devices characteristics under the influence of external actions (thermal, strong electric and magnetic fields, SHF-radiation, laser radiation, etc). Electrophysical characteristics of this devices, in particular, are defined by structural defects of semiconductor. In the growth process and technology treatment of a crystal the undesirable defects are introduced. Active external actions are the promising methods of defects control. An influence of external actions depends on energetic parameters, its intensity and dose and this actions result in different effects inside substrate and epitaxial device structures, including their structural ordering and relaxation of intrinsic stresses (ISs) under the influence of small dose radiation or structural disorder and additional defects generation under the influence of great dosage.

The purpose of this review is analysis of literary information about influence of external action on electrophysical characteristics of surface-barrier structures (SBS) with Schottky barrier at the example of GaAs structures and their stability to external actions.

GAMMA-QUANTUM ^{60}Co IRRADIATION

Radiation effects in semiconductor diode structures with Schottky barrier are researched by many authors in connection with radiation stability of solid-state electronic devices [1–4]. In parallel with this it is shown that gamma-quantum irradiation and fast electron irradiation can be used to improve characteristics of device structures. In this connection in literary it is widely discussed a small dose effect. Small dose effect, which is observed under the influence of gamma-quantum ^{60}Co small dose irradiation and fast electrons irradiation of silicon, gallium arsenide, indium antimonide. This effect is discussed by many authors and the most completely is represented in the monograph [5]. We note that effect of small dose radiation on structural impurity ordering in the area of junction metal-GaAs was firstly discussed by authors [2]. This effect go with correlation of diffusion length of minority charge carrier L_p and imperfection factor n of gallium arsenide Schottky diodes. When radiation doses are comparatively small, it leads to growth of L_p in the contact area of GaAs and, as a rule, to decrease of imperfection factor n. In this case Schottky barrier height φ_h changes slightly. In case of high dose irradiation L_p and φ_h decrease and n growths essentially. Thus, we observe a correlation of changes L_p and n under the influence of ^{60}Co gamma-radiation. Proposed by authors [2] defect crystal ordering process by small dose ionizing radiation is generalized in paper [4] and it occurs in such way: ionizing radiation stimulates atom subsystem excitation and, as a result, the radiation energy propagates to impurity atoms and defects, generates their intensive migration and complex defects breakdown.

In paper [3] was researched a change of dependence of minority charge carriers lifetime in gallium arsenide and silicon on ^{60}Co gamma-quantum integral flow. Authors [3] show that minority charge carrier