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Peculiarities of Stable Oscillations of High Amplitude Current Occuring in Long High-Impedance Planar-Epitaxial Gallium-Arsenide-Based Structures

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Abstract—The results of experimental investigation for determining the effect of different factors (distance between contacts, type of contacts, and the grade of virgin wafers) on the origination of stable oscillations of high amplitude current in long planar-epitaxial structures based on high-impedance semi-isolating *n*-type gallium arsenide have been presented. It was found out that the distance between the anode and cathode contacts was a key factor determining the emergence of stable oscillations of high amplitude current in such structures.

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INTRODUCTION

The functional electronics is one of the promising future-oriented directions of the development of modern solid-state electronics [1, 2]. The construction of functional electronics devices generally involves the need of using nonlinear active media that make it possible to create dynamic heterogeneities, such as domains of strong electric field, charge packets, space-charge waves, etc.

Such media include *n*-type gallium arsenide, where negative differential conductivity (NDC) and the corresponding current instability (the Gunn effect) occur due to the intervalley transfer of electrons in strong fields [3–5]. In addition, a fundamentally different type of current instability known as recombination or concentration type in *n*-type gallium arsenide can be observed in strong electric fields; this type of current instability is determined by the cross-section of free electrons capture at deep acceptor levels in the bulk of semiconductor dependent on electric field intensity [5–7] or by the charge-exchange of surface states [8] (surface-barrier instability of current).

The recombination type of current instability is characteristic for a semi-insulating semiconductor due to the presence of capture levels therein (in particular EL2) [9–12]. The speed of slow recombination domains is much (essentially) lower than the speed of Gunn domains, however in this case the amplitude of emerging current oscillations can be much higher, since at the instant of electron capture their concentration significantly decreases with respect to the equilibrium condition [5].

Due to a variety of physical factors, the impact of which cannot be always effectively controlled, the recombination instabilities of current occupy a leading place among the other kinds of instabilities in terms of both, the number and inconsistency of available literature data. The majority of them are devoted to the bulk structures. However, the investigation of recombination instabilities of current in long planar-epitaxial structures is of interest both from the scientific and application viewpoints, since it offers opportunities for creating various devices: functional low-frequency generators, meters and converters of complex information signals in infrared (IR) and optical ranges [7, 11, 12].

As reported in [13], low-frequency oscillations of current and frequency occur in long high-impedance planar-epitaxial structures based on *n*-type gallium arsenide. The amplitude and waveform of the above oscillations can be determined to a significant degree by the value of applied voltage, intensity and localization of illumination and also by a number of other factors. However, specific factors determining the onset of recombination instability of current in the specified structures and the degree of their importance were not studied in detail in [13].