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THE IMPACT OF ENERGY AND DELAY ANGLE OF INJECTED CARRIERS ON ENERGY CONVERSION EFFICIENCY IN A GUNN DIODE WITH AN INTRICATE CATHODE

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The paper is devoted to numerical investigation of the influence of the energy and delay angle of injected carriers on the energy conversion efficiency at the fundamental mode in an *n*-GaAs Gunn diode with an intricate cathode. An increase in the energy of the carriers injected into the diode's active region (for the delay angles within a range corresponding to positive values of the diode efficiency) is shown to lead to a shift of this range towards larger angles of lag. A new structure of the Gunn diode is suggested, which involves special cathode contacts consisting of alternating quasiisland ohmic contacts and control electrode domains.

It is customary to design Gunn diodes based on n^+–n–n^+-structures. The cutoff frequencies and efficiency of such diodes depend by and large on the length and doping level of the active region. Improvement of the frequency properties of these diodes is related with generation of hot electrons by creating a built-in longitudinal electric field in the diode cathode region. This approach is employed in Gunn diodes with Schottky barrier, with hot electron injectors [1], with an intricate cathode [2], etc. A distinctive feature of such devices is then reduced length of the carrier initial heating as compared to the Gunn diodes with ohmic contacts.

Further improvement of Gunn diode frequency properties is related to injection, into the diode's active region during the period of external signal, of only those electrons that make a positive contribution to efficiency of energy conversion, so that selection of the injected electrons takes place. Consider the physical prerequisites, which make it possible to implement such selection of the carriers, taking a Gunn diode with an intricate cathode as an example [2, 3].

Figure 1*a* presents a sketched depiction of a cell of periodic structure of a Gunn diode with an intricate cathode [2] including a cathode region *ABSNM*, an anode region *DEFG*, and an active region *BDGMN*. Between the electrodes of anode *EF* and of cathode *AM* the external voltage $U_{EF}(t) = U_0 - U_1 \cdot \sin(\omega t)$ is applied, where U_0 and U_1 are the voltage modes whose selection provides for the transit conditions of the enriched layers, and at the fundamental mode the efficiency of the diode is close to its maximum value. The segments *AN* and *NM* are, respectively, a quasiisland ohmic contact (*AN* << *NM*) and reverse-biased Schottky barrier without current in it. The electrons are injected from the quasiisland n^+-domain of the ohmic cathode contact *ANSB* into the active n-region *SBDGMN* of the diode (*AB* << *BD*), interact with the electromagnetic wave, give up their kinetic energy to it, and reach the anode n^+-region *DEFG*. However, injection of the carriers into the active region of the diode lasts during the whole period T of the external signal, i.e., selection of the injected carriers does not occur.

Figure 1*b* shows the design of a cell of a new periodic structure for a Gunn diode with a quasiisland ohmic contact and control electrode. This cell performs selection of electrons injected into the diode's active region and includes an additional p^+-domain *CHMNSB*, while the segments *AN* and *NM* (*AN* << *NM*) are ohmic cathode contacts. Here the potential of the segment *NM* is chosen so that it shows a negative magnitude with respect to the potential of the segment

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