NUMERICAL SIMULATION OF A PHOTOCURRENT LIMITED BY A VOLUME CHARGE IN A PHOTONIC DIELECTRIC CRYSTAL

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The problem of a flat diode is considered, where a dielectric crystal in the interelectrode gap is used as an insulator. A diamond crystal is used as a dielectric. A voltage is applied to the anode, and a monopolar injection appears, a volumetric charge is formed, limiting the current. The cathode operates in the mode of unlimited emission capacity [1]. Based on this problem, the Gurney-Mott law is formulated. The law describes the dependence of the current density at the anode on the square of the voltage between the cathode and the anode in a dielectric crystal with size *d*.

$$j = \frac{9\varepsilon\varepsilon_0\mu}{8d^3}U^2 \tag{1}$$

The paper provides numerical simulation of the motion of electrons in a dielectric crystal and the effect of the volume charge on the current density. Numerical modeling is carried out by the particle-in-cell method. The problem according to the Gurney-Mott law is solved by the numerical method of particles in cells. In this method, a grid is superimposed on the calculated area, in the cells of which particles move. Each particle, which can be mistaken for a cloud of spatial charge, is linearly the same size as the size of a grid cell. To solve the Poisson equation, this method uses a finite difference scheme and a tridiagonal matrix algorithm. The Gurney-Mott law has been verified by this method. The simulation points coincided with the analytical curve.

The problem of the occurrence of a photocurrent in a photonic crystal under the action of a laser on the surface of a sample is considered. Under these conditions, the formation of CVLC in a dielectric crystal with a variable dielectric constant ε as ε(x) from the cathode to the anode was verified by the particle-in-cell method. Such a crystal can be a diamond, since it is a natural material, the value of which can vary from 5.5 to 10. The simulation result showed that the current density increases linearly with an increase in the ε difference between the cathode and the electrode. Based on this simulation, it was decided to implement a photocurrent in a photonic crystal.

To verify the results of numerical simulation of a photocurrent limited by a volume charge, the Gurney-Mott law is used in a dielectric crystal in the following form [2]:

$$j = \frac{9\varepsilon\varepsilon_0\mu}{8}\frac{N_C^{1/l}}{N_t}\left(\frac{\sigma_{omn}f}{<v\sigma>}\right)^{1-\frac{1}{l}}\frac{U^2}{d^3} \tag{2}$$

A photonic crystal is a crystal that consists of parallel layers with periodic values of dielectric constant, the period of which is equal to the wavelength [3] (Fig. 1). In this simulation, a photocurrent limited by a volumetric charge is realized in a photonic dielectric crystal. Current density values are obtained for different widths of diamond films. The simulation result showed that with a decrease in the width of the films and an increase in their number, the current density at the anode does not change

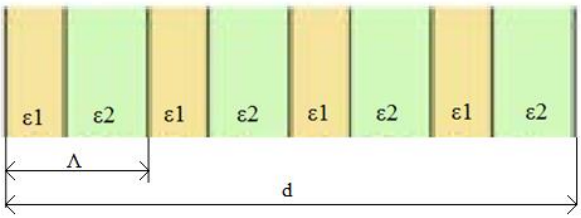

Fig.1. The periodic structure of a photonic crystal.

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