Dynamics of generation of free carriers in silicon with different types of doping under the influence of terahertz pulses

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Research into the generation dynamics of free charge carriers in semiconductors under the influence of terahertz pulses continues to be relevant and in demand in the development of new electronic and optoelectronic devices, which are controlled in the picosecond time range. Advances in the generation of terahertz pulses with a high electric field strength of tens of MV/cm have made it possible to conduct experimental studies of nonlinear processes in various materials without involving complex technological processes associated with the manufacture of metamaterials. The paper presents the results of experimental and theoretical studies of the role of electron and hole impact ionization in the generation of free carriers in n- and p-type doped silicon under the influence of two-cycle terahertz pulses with an electric field amplitude of 20 MV/cm. It is shown that the maximum electron concentration in the conduction band is formed at the end of the first period of the electric field, the value of which is the same for n- and p-type silicon. The analysis of the obtained results was carried out using numerical simulation of the processes of electron and hole impact ionization in these silicon samples. A simple model was proposed that takes into account the impact ionization of both electrons and holes, which influence each other. The results of numerical calculations showed good similarity with experimental results