**Ultrafast All-Optical Switching due to Photon-Avalanche-Like Effects in Quantum Wells**

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In this study, several new features of nonlinear optical excitation of materials with quantum wells (QWs) under short laser pulses are treated. The following processes were considered in previous works:

a) “traditional” photon-avalanche (PA)-like processes (type I) in systems of impurity ions [1] and in deep QWs [2]: for this type of processes the photon absorption and the energy transfer between electrons are involved in different elementary events;

b) type II PA-like processes: single- or many-photon [3] absorption and the energy transfer are involved in one elementary event in bulk crystals with special types of the energy band structure [4], wide-gap crystals with high concentration of deep impurities [5], and QWs [6];

c) efficient up-conversion and light-with-light controlling due to both type I and type II PA processes in deep QWs [6].

Quantum-mechanical calculations of the probabilities of elementary processes involved in phenomena under consideration were performed within second or higher-order perturbation theory. The results of these calculations were applied to analyze kinetics of non-equilibrium electron-hole pairs producing, optical transmission, and optical switching the media between states with essentially different optical and/or electrical properties.

General nonlinear oscillation analysis is applied where laser radiation intensity j is considered as a bifurcation parameter [7] In general, theoretical description of type II PA dependence from bifurcation parameter value is observed.

It was shown that in all cases under consideration a rather narrow region of laser intensities j appears where both populations of electron states and optical transmission dramatically change even at small change of j. A number of crystals and heterostructures, whose electron band structure and geometric parameters allow the above-described transient nonlinear processes of photoexcitation and optical switching, are described in detail.

Typical times τ and densities of light energy E for all-optical switching are estimated as τ~0.1÷10 ns and E~0.1÷10 pJ/cm2 respectively.

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