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Time and temperature stability of radiation-induced changes in optical properties of ternary chalcogenide glassy semiconductor systems

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The time and temperature dependences of γ-induced changes in optical properties of As–Sb–S, Ge–As–S and Ge–Sb–S ternary chalcogenide glassy systems have been studied. It has been established that the time dependence of the observed radiation-induced effects is described adequately by the universal De-Bast-Gilard relaxation function. The temperature dependence of the static component of radiation-induced darkening is characterized by three different processes connected with relaxation of defects created by γ-irradiation.

Изучены временные и температурные зависимости γ-индуцированных изменений оптических свойств халькогенидных стекол в системах As–Sb–S, Ge–As–S и Ge–Sb–S. Установлено, что временная нестабильность радиационно-индуцированных эффектов адекватно описывается универсальной релаксационной функцией Де-Баста-Джилларда. Температурная зависимость статической составляющей радиационно-индуцированного потемнения характеризуется тремя различными процессами, связанными с релаксацией дефектов, образовавшихся при γ-облучении.

In connection with application of chalcogenide semiconductor materials, including amorphous ones, in modem optoelectronics as active media for optical compact discs (CD) and digital versatile discs (DVD) with possibility of multiple rewriting [1, 2] of great interest is to research the influence of external factors such as light, pressure, radiation, temperature, etc., on optical properties of chalcogenide vitreous semiconductors (ChVS).

In previous papers [3–7], we have studied the main physical regularities of influence of high-energy γ-irradiation on optical properties of some ternary ChVS systems. Among the main obtained scientific results, the following ones are to be noted: the radiation-induced long-wave shift of optical transmission edge in the fundamental absorption region (radiation-induced darkening effect) [3–5]; the existence of dynamic (relaxing in time) and static (which becomes stabilized during 2 to 3 months after the sample irradiation) components of this effect [4, 5]; the significant dependence of magnitude and character of radiation-induced changes on the ChVS chemical composition [3–5]; the proposed interpretation of composition features of radiation-induced effects (RIE) within the concept of free volume and redistribution of covalent chemical bonds [4]; the microstructural RIE mechanism based upon the coordination defect formation model [6]; a new approach in explanation of radiation-induced structural transformations in ChVS using positron annihilation method [7], etc.

The temperature and time dependences of RIE in ternary ChVS such as As–Sb–S and Ge–As–S were studied in part, too [8, 9].