Interdiffusion in chalcogenide semiconductor superlattice nanostructures

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The nanostructures based on chalcogenide semiconductors (PbS, PbSe, PbTe, EuS, EuSe, SrS, YbS, YbSe) open wide opportunities both for fundamental researches in the field of solid state physics, and for creation of new functional elements of microelectronics. For such structures with superthin layers the very important meaning has a condition of interfaces and temporary and temperature stability of their structure and properties. The investigation of layer interdiffusion in superlattices (SL) has the very important meaning both in theoretical and in practical aspects.

One of the most effective methods for investigation of SL's is the x-ray diffraction, which allows on the changing of near-Bragg peak satellite intensity not only to look after processes of layer intermixing but also to determine their interdiffusion coefficients:

$$\mathrm{Ln}[I_k(\tau_2)/I_k(\tau_1)] = -8k^2\pi^2 D(\tau_2-\tau_1)/H^2 \qquad (1)$$

Where: D - diffusion coefficient; H - period of SL; k - order of satellite; I_k - relative intensity of k-th satellite normalized on zero satellite intensity; τ -annealing time.

The subject of research of this work are chalcogenide semiconductor SL's which were made in oil-free vacuum (10^{-4}- 10^{-5} Pa) by thermal evaporation and their consecutive condensation onto (001)KCl at 500 K. Layer thickness and condensation speed were supervised by the calibrated quartz resonator located near to the substrate. The samples were annealed in vacuum at different temperatures for each SL's.

The layer interdiffusion coefficients were determined for each SL's using expression (1). For example, for EuS-SrS SL there were

D = $6{,}2\times10^{-21}$ см^2/s (673 K);
$4{,}6\times10^{-20}$ см^2/s (723 K);
$1{,}1\times10^{-18}$ см^2/s (773 K).