Local Annealing by e-Beam and *in Situ* TEM of Amorphous-Crystalline Transition in Chalcogenide-Based Films

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Abstract

Though chalcogenide-based films are used for information storage the detailed microstructure characterisation of the recrystallised areas seems lacking.

Using some initially amorphous condensates (Sb_2Se_3 and bilayers Ge-Sb_2Se_3, Ge-Te, Se-Te) we study the crystals growing under the influence of local electron beam (e-beam) annealing in transmission electron microscope (TEM). Primarily we focus on the most specific feature inherent to amorphous-crystalline transition - internal crystal lattice bending [1] (new term [2] - "transrotational" structure). Extinction bend contours which indicate such kinds of regular imperfections on the TEM images of crystallised areas of chalcogenide films are widespread (e.g., see [3-5]). We used bend contour method preferentially for measuring of local and integral magnitudes of lattice bending and for estimates of geometry and general character of lattice disorientations in the crystallized areas.

Amorphous films (10-10^2 nm thick) were prepared by vacuum evaporation. To study the effect of thickness and composition the films with strong gradient either of thickness (Sb_2Se_3) or relative layer thickness (bilayers Ge-Sb_2Se_3) or composition (Ge-Te, Se-Te) were used.

Strong internal lattice bending around axes lying in the film plane are observed for all the materials studied. In Sb_2Se_3 films the internal lattice bending strongly increases as the film gets thinner, Fig. 1, while growth rate decreases. In Ge-Sb_2Se_3 bilayers with variable thicknesses of the layers the influence of Ge layer on the crystal growth and microstructure can be more or less pronounced but depends upon the layer position (sublayer or overlayer), in particular the intensity of the e-beam drastically influence the crystallization and the structure of crystallized spot in the case of Ge sublayer, Fig. 2. In Ge-Te and Se-Te films the relative concentration influences the internal lattice bending (for the last system also strongly affects the nucleation density).

It is obvious that the role of some microstructure parameters (i.e. magnitude of internal lattice bending) is under-estimated whereas it can strongly influence the time and energy needed for rewriting.

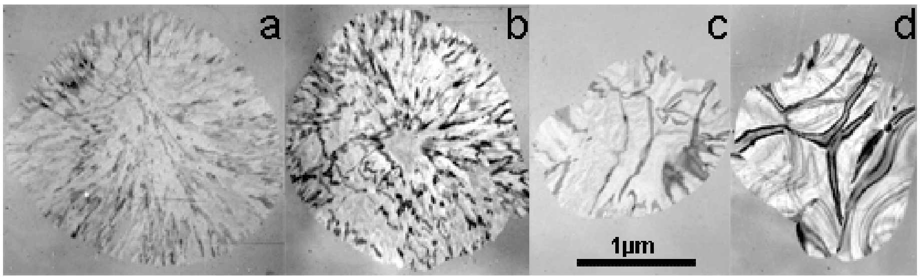

Fig. 1. The variation of the microstructure of crystallized spots in Sb_2Se_3 film across film thickness (increases from **a** to **d**).

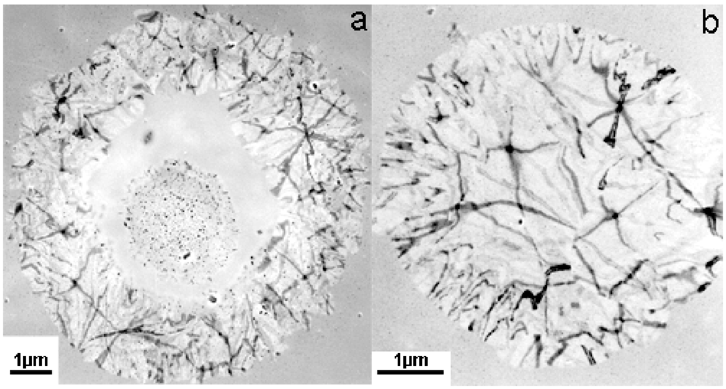

Fig. 2. Different structure of the crystallised spot in Ge-Sb_2Se_3 bilayer resulted from different e-beam intensity (a – stronger).

This work is partially supported by INTAS (00-100), pending support from RFBR.

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