Invited Papers

Interaction of chalcogenide glass/Ag dual films structures with e-beam and evaluation of the occurring effects on the performance of CBRAM devices

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Among the many applications of chalcogenide glasses, their involvement as an active layer in redox-conductive-bridge-memory (CBRAM) devices triggers particular interest because of their potential to replace CMOS-based NAND and flash memory. In these devices the chalcogenide glass film is in contact with a silver film, and it is of a practical interest to understand how different external events, for example irradiation with an beam of electrons can influence this dual layer structure in order to identify how the performance of the CBRAM devices will be affected.

To understand the nature of the effects occurring in these devices under influence of electron-beam radiation, the interaction of blanked chalcogenide films and nanostructured films containing chalcogenide glass and silver (Ag) source are studied. Raman spectroscopy, energy-dispersive X-ray spectroscopy and X-ray diffraction are used for establishing the structural and compositional effects occurring under irradiation. The same film configurations were used to build CBRAM devices, which are characterized by their resistance states, threshold voltage and endurance.

The complex study of the occurring effects reveals that the e-beam irradiation affects the structure of Ge–Se films. The effect is further enhanced by silver diffusion into the chalcogenide films as a result of interaction with electrons. The electric field that forms during the bombardment of the Ge–Se films with electrons causes changes in the density of films and ion migration. This introduces silver across a much greater distance than the thickness of the studied CBRAM devices. As a result, their performance is affected by the presence of diffusion products such as silver selenide and argyrodite. Their amount and microcrystal growth are related to the structure of the accepting chalcogenide matrix. We suggest that the stabilization of the performance of the CBRAM devices, under the influence of e-beam, can be achieved by saturation of the chalcogenide network with silver prior to the e-beam interaction – the technology of devices fabrication has to include a step for silver diffusion and saturation during device formation.