NCM 13

13TH INTERNATIONAL CONFERENCE ON THE
STRUCTURE OF NON-CRYSTALLINE MATERIALS

HALIFAX – CANADA
JULY 24-29, 2016

Josef Zwanziger, Chair

Poster P04

PHASE TRANSITION "GLASS-CRYSTAL" AND SWITCHING EFFECT IN NANOSCALED $Ge_2Sb_2Te_5$ FILMS MODIFIED BY BISMUTH IMPURITY

S. Dyussembayev[1], O. Prikhodko[1], A.Sazonov[2], Zh. Tolepov[1], N. Almasov[1], S. Maksimova[1], N. Guseinov[1], S. Kozyukhin[3]

[1]*IETP, al-Farabi Kazakh National University, Almaty, Kazakhstan*
[2]*University of Waterloo, Waterloo, Canada*
[3]*Kurnakov Institute of General and Inorganic Chemistry, Moscow, Russia*

Corresponding author: sanzhar.dyussembaev@gmail.com

It is well known that in the films of $Ge_2Sb_2Te_5$ chalcogenide glassy semiconductor under the external influences (light or voltage pulse) the reversible phase transition "glass-crystal" takes place. It allows to create the optical storage devices such as DVD, Blu-Ray and especially the new generation of non-volatile memory cells such as Phase Change Memory (PCM) on the base of these films. The embedding of metal impurity in the films can reduce the crystallization time and increase the speed of memory cells. However, the features of phase transition in the metal-modified $Ge_2Sb_2Te_5$<M> films of have not been studied well.

This work presents the results of the study of the structure and switching effect observed in nanoscale films of $Ge_2Sb_2Te_5$ modified by Bi ($Ge_2Sb_2Te_5$<Bi>).

The $Ge_2Sb_2Te_5$<Bi> films with thickness ranged from 50 to 200 nm were obtained by ion-plasma magnetron sputtering of combined target $Ge_2Sb_2Te_5$-Bi in argon atmosphere. Bismuth concentration in the films was 6 and 12 at.%.

By the method of HR-TEM imaging (Fei-Titan) it was found that the structure of $Ge_2Sb_2Te_5$<Bi> films presents the amorphous matrix with isolated crystalline nanoregions (nanoclusters) of metallic bismuth with average size ~ 8 nm.

Local atomic structure of the films was studied by Raman spectroscopy using He-Ne red laser with wavelength 632 nm. It was found that under the laser irradiation there is the structure transition of nanoscale $Ge_2Sb_2Te_5$ films from amorphous into polycrystalline hexagonal stable state through metastable polycrystalline cubic phase. In contrast, in the $Ge_2Sb_2Te_5$<Bi> films the transition from amorphous to polycrystalline hexagonal stable state under the laser irradiation occurs without intermediate metastable cubic phase.

The study of the switching effect showed that in $Ge_2Sb_2Te_5$<Bi> films there was a significant reduction of the switching time and threshold voltage in comparison with $Ge_2Sb_2Te_5$ films. The improvement of the switching parameters in the bismuth modified nanoscale $Ge_2Sb_2Te_5$ films, it is obvious, due to the peculiarities of the "glass-crystal" phase transition in these films.

This work was carried out on 4607/GF4 grant of Committee of Science of ESM RK.