Multiple switching effects in GeSbTe thin-films

S. Fefelov[1], L. Kazakova[1,2], N. Bogoslovskiy[1], P. Lazarenko[3]

[1]*Ioffe Institute, St. Petersburg 194021, Russia*
[2]*St. Petersburg State Forest Technical University, St. Petersburg 194021, Russia*
[3]*National Research University of Electronic Technology, Zelenograd 124498, Russia*

Corresponding author: nikitabogoslovskiy@gmail.com

The switching and memory effects in chalcogenide glassy semiconductors are actively studied both experimentally and theoretically during the last years. Possible mechanisms of these effects are widely discussed. In this paper, we present an experimental study of switching and memory effects by an original method with a current generator. In order to measure the I-V curve, triangular current pulses are applied to the sample and the voltage on the sample is measured. The advantage of this method is that it allows to separate the effect of voltage and current on switching and study the conducting state at low current values.

The measurements were carried out on thin-film GeSbTe samples using a top clamping electrode with an area of approximately 10^{-4} cm^2. In the case of such a large electrode, a filament with a high current density is formed in the sample during switching. Subsequently, crystallization occurs inside the current filament, thus the size of the crystalline region is determined by the filament radius. We applied several current pulses with an increasing current amplitude to the same point of the sample and observed multiple sequential switchings. This phenomenon can be explained by the fact that, the voltage on the sample increases due to the small size of the crystalline filament, and a new switching occurs in the region near the filament with higher temperature. Therefore, the new switching occurs at a lower threshold voltage, which agrees with the electronic-thermal model of the switching effect. Also we obtained that the resistance of the current filament is inversely proportional to the maximum current in the pulse, which is the evidence of the constant current density in the filament. Obtained results are important for understanding the mechanism of the switching effect.

Photoconductivity of chalcogenide thin film heterostructures

O. Iaseniuc, M. Iovu

Institute of Applied Physics, No 5 Academiei Str., Chisinau, MD-2028, Republic of Moldova;

Corresponding author: miovusel@gmail.com

Arsenic selenide and sulfide glasses are well known as high photosensitive materials with a wide application in photonics, optoelectronics and information storage systems. In the present paper the experimental results on steady-state and transient photoconductivity of amorphous heterostructures Al- $As_{0.4}S_{0.3}Se_{0.3}/Ge_{0.09}As_{0.09}Se_{0.82}/Ge_{0.30}As_{0.04}S_{0.66}$-Al at different values of the applied voltage of positive and negative polarity at the illuminated top Al electrode are presented and discussed.

The thickness of the component layers are also different with the ratio of ~1.0/0.5/0.2 μm. The investigated multilayer structures contain the first material with the trigonal, and the other two contain trigonal as well as tetrahedral structural units.

Fig.1 and 2 show the spectral distribution of the photocurrent of the investigated multilayer structure at different polarity and values of the applied electrical voltage to the top Al-illuminated electrode. The rich structure of the spectra are governed to the different value of the optical band gap of the involved amorphous layer (about 2.0 eV for the first two, and about 3.0 eV for the latest). The obtained experimental results are discussed taking into account the depth of the light absorption depending of the nature of each amorphous material, wavelength and the contact phenomena at the interfaces of the different material as well as the interfaces metal-amorphous semiconductor with different work functions, as was demonstrated for other amorphous thin film structures [1].

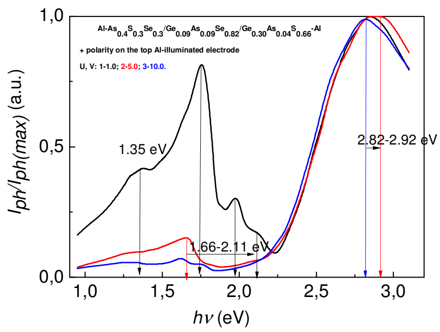

Fig. 1. Photocurrent spectra of amorphous thin film structures Al- $As_4S_3Se_3$ / $Ge_{0.9}As_{0.9}Se_{8.2}$ / $Ge_{.3}As_{0.4}S_{6.6}$-Al at positive applied voltage to the top Al-illuminated electrode U (V):.1 - 1.0; 2 - 5.0; 3 - 10.0.

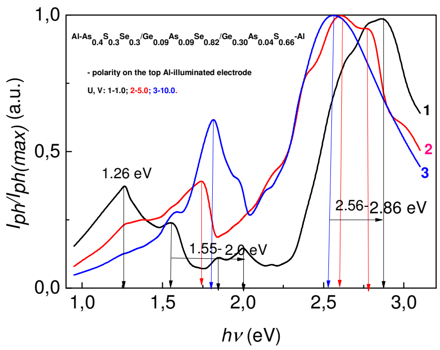

Fig.2. Photocurrent spectra of amorphous thin film structures Al- $As_4S_3Se_3$ / $Ge_{0.9}As_{0.9}Se_{8.2}$ / $Ge_{.3}As_{0.4}S_{6.6}$ - Al at negative applied voltage to the top Al-illuminated electrode U (V):.1 - 1.0; 2 - 5.0; 3 - 10.0.

References

[1] M. Popescu, A. Andries, V. Ciumas, M. Iovu, S. Sutov, D. Tiuleanu. Fizica sticlelor calcogenice, Editura Stiintifica Bucuresti & I.E.P. Stiinta - Chisinau, 1996.