Electrophysical properties of indium doped $As_2S(Se)_3$ thin films

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Amorphous arsenic chalcogenides $As_2S(Se)_3$ are well-known semiconductor materials which, being exposed to light of appropriate energy and intensity, often undergo changes of electronic and atomic structure, composition, phase, physical and chemical properties generally known as photoinduced effects. These changes can be reversible or irreversible and have led to extensive applications of amorphous chalcogenides, the most well known of them being related to optical data storage as well as xerography, photovoltaic and photoconductive elements, laser printers, light-sensitive camera tubes, high-speed optical switches, X-ray radiography, etc. It is known that optical and electrical properties of amorphous As_2S_3 and As_2Se_3 can be noticeably modified by doping. Moreover, in an amorphous chalcogenide with a high dopant content one can also expect photoinduced phase separation when part of the material crystallizes in a surrounding amorphous matrix [1, 2].

In-doped $As_2S(Se)_3$ films with In content x ranging from 1 to 5 % were obtained by thermal vacuum evaporation from two independent tantalum evaporators on glass substrates at the temperature of 500–550 K for In and 1050–1100 K for $As_2S(Se)_3$. The deposition rates were 3–5 nm/s. Electrophysical studies in the interval 293–373 K were performed by dc measurements on a standard resistance (R_e) connected in a series with the sample.

The temperature dependence of the resistance of $As_2S(Se)_3$:In thin films is proved to depend significantly on the modifier concentration. It is shown that the activation energy decreases with In content ($1 \le x \le 5$ %) for As_2Se_3:In in the range of 1.5÷1.47 eV and for As_2S_3:In the interval of 1.6÷1.53 eV. I-V characteristics of the dark current and the current under the illumination of $As_2S(Se)_3$:In films were investigated. The values of conductivity under illumination and in the darkness are not set instantaneously, but with a certain relaxation time. This relaxation effect can be explained by possible accumulation of charge on the defect levels. Possible mechanisms of photoelectric memory in $As_2S(Se)$:In thin films are discussed.

1. Ke. Tanaka, K. Shinakawa, *Amorphous Chalcogenide Semiconductors and Related Materials* (Springer, Berlin, 2011).
2. T. Ohta and S.R. Ovshinsky, *Phase-Change Optical Storage Media*, in: *Photo-Induced Metastability in Amorphous Semiconductors*, edited by A.V. Kolobov (Wiley-VCH, Weinheim, 2003), 310.