Amorphous chalcogenides based microcells for the fast toxic gas alarm-triggering

Dumitru Tsiulyanu[1*], Marina Ciobanu[2]

[*1,2]Technical University, Faculty of Electronics and Telecommunication, Department of Physics, Chisinau, Moldova.

*[1]ORCID No: https://orcid.org/0000-0003-3711-4434

[2]ORCID No: https://orcid.org/0000-0002-5178-2167

*[1] tsiudima@gmail.com ,tel:(373)69307322, [2]ciobmarina@gmail.com ,tel:(373)68861420

Abstract

A brief review of structure, physical properties and application of amorphous chalcogenides (ACh) in technology of the chemical sensors is reported and discussed in context of development of the novel principles of operating, enhancing their speed at gas detection. For this purpose are considered the simultaneous involvement of contact and surface phenomena in sensor mechanism of operation, as well as utilization of dielectric - metal transition in ACh based solid electrolytes triggering of which can be controlled by gas adsorption. Both these two approaches have been experimentally realized and the proposed principles proved in the framework of this study. In the first case the microcell consists of a Si/ SiO_2 /ACh wafer at that ACh is a gas sensitive ultra-thin amorphous layer of a low forbidden gap (< 0. 4 eV) grown between previously deposited Pt electrodes and, what is more the work function of ACh should not exceed the work function of Pt. To elucidate the mechanism of this fast response (~5 sec.) sensor it has been investigated by AFM, SEM and EDX analyses followed with its characterization via studying the current - voltage characteristics, dynamic response, long – term stability, effects of temperature, humidity and other gases. The further increasing of the speed of chemicals detection has been achieved by combining the above examined sensor with a high speed switcher operating on principle of dielectric - metal transition in ACh based solid electrolytes. In the present study the glassy chalcogenide based solid electrolytes have been fabricated via photodissolution of Ag in thin films of different ACh grown in vicinity of gas sensitive ACh on the same Si/SiO_2 wafer. It was pointed out that the occurrence of toxic gas, even in trace amounts causes the switching threshold of the solid electrolyte based microswitcher to shift and, as a result the sudden increase of the current by several orders of magnitude. The time of switching that is the triggering time lies in the order of microseconds. It is worth noting also that the fabrication of examined alarm-triggering microcells requires application of only standard microelectronic technologies.

Keywords: Nanotechnology; Chalcogenides;Toxic gases: Alarm-triggering.