Evidence of $SnSb_2Te_4$ rocksalt metastable phase of thin films grown by pulsed laser deposition

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$SnSb_2Te_4$, an intermetallic compounds in the pseudobinary $SnTe-Sb_2Te_3$, looks as a promising candidate for phase-change material in non-volatile memories applications. Thin films having thickness from 50 to 150 nm were grown by pulsed laser deposition using $SnSb_2Te_4$ as structure of 21 *R*-type structure (*R-3m*) consisting of rocksalt-type blocks separated by van der target. While in thermal equilibrium this phase crystallizes into a complex cubic close-packed Waals gaps [1], the thin films obtained had a simple NaCl-structure (*Fm-3m*) (metastable phase) as it was deduced from conventional XRD measurements in grazing incidence of the investigated films. The metastable phase transitioned to the stable complex structure during the measurements of electrical resistance on temperature dependence. ^{119m}Sn conversion electron Mössbauer spectroscopy was used to investigate the local environment of Sn atoms in as made film. The existence of Sn(II) in a high symmetry site was found as expected for $SnSb_2Te_4$. Nevertheless, the dominant contribution was Sn(IV) attributed to SnO_2 phase, evidencing an oxidation of the films surface.

The evidence of the metastable NaCl-structure of $GeSb_2Te_4$ films induced by heating the amorphous film by laser irradiation were reported [2-4]. Nevertheless, reports about $SnSb_2Te_4$ film to date were not found.

Keywords: crystal structure, thin films, metastable phase

References

[1] O.Oeckler, M.N.Scheider, F.Fahrnbauer, G.Vaughan, *Solid State Sciences* 13 (2011) 1157

[2] G.Fuxi, X. Songsheng, and F. Zhengxiu, *Annalen der Physik* 1 (1992) 391-398

[3] T.Matsunaga and N.Yamada, *Physical Review B*, 69 (2004) 104111

[4] J.Tomforde, W. Bensch, L.Kienle, Ph.Merkelbach and M. Wuttig, *Chemistry of Materials* 23 (2011) 3871

Thin films of porphyrin-chalcogenide nanocomposite for methane sensing at room temperature

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Methane is one of the components of natural gas and has multiple applications. It is an odorless gas, flammable and combustible in the presence of oxygen. Its lower explosion limit (LEL) is 5.0 vol.%, which corresponds to 50 000 ppm, while the upper explosion limit (UEL) is 15 vol% [1]. The classical and versatile SnO_2 gas sensing material was initially developed by researchers from Japan, several decades ago [2]. The gas sensing material is generally deposited onto planar interdigitated electrodes (IDEs), or onto some functionally equivalent structure, like coils or meshes. The back side of the IDE is provided, in most cases, with a continuous electrode for heating, to allow setting the working temperature of the sensor for the gas to be detected.

There are many research groups worldwide working intensly in the field of gas sensing materials [2-11].

It is a challenge to find alternative gas sensing materials to the SnO_2, which has an operating temperature for methane as high as 600 ^oC [9-11]. The high value of the operating temperature is a serious drawback in the case of remote in-field applications, where energy supplies for heating the sensor might not be easily available. As such, room temperature (RT) sensing materials are highly desired.

The nanocomposite thin films have been prepared starting from $SnSe_2$ powder and Zn(II)-5,10,15,20-tetrakis-(4-aminophenyl)-porphyrin powder (ZnTAPP). These powders have been dissolved in amine- and methyl-containing solvents, ultrasonically mixed and dropcasted onto a sensor support with interdigital metal electrodes.

The methane sensing tests have been carried out at room temperature, using synthetic dry air, which alternatively contained or not, a flux of 1000 ppm of methane, for a period of 10 minutes for each alternation. The variation of the electrical resistance was of linear drop in the presence of methane and a corresponding linear increase, when only the synthetic dry air was present.

These nanocomposite thin films proved to be sensitive to methane in concentrations as low as 1000 ppm at room temperature of about 25 ^oC, without the need for heating the sensing element.

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References :

[1] https://www.mathesongas.com/pdfs/products/Lower-(LEL)-&-Upper-(UEL)-Explosive-Limits-.pdf

[2] Fukui, K; Nakane, M. *Sensors and Actuators B-Chemical* Vol.: 25 Iss.: 1-3 (1995) 486-490.
[3] S. Marian, K. Potje-Kamloth, D. Tsyulyanu, H.-D. Liess, *Thin Solid Films* 359 (2000) 108.
[4] D. Tsiuleanu, S. Marian, K. Potje-Kamloth, H.-D. Liess, *DE Patent* No. DE 100 19010 A1, issued on 25/10/2001.
[5] David B. Mitzi, *US Patent* No. 6875661, Issued on 4/05/2005.
[6] Liu Hui-fang; He Qi-xin; Zheng Chuan-tao; Wang Yi-ding, *Optoelectronics Letters*, Vol. 13 (2) Pp: 100-103, DOI: 10.1007/s11801-017-6286-4, Publ. MAR 2017
[7] Ma, Hongyu; Qin, Shunli; Wang, Liying; Wang, Gang; Zhao, Xiaohu; Ding, Enjie, *Sensors and Actuators B-Chemical*, Vol. 244 Pp: 17-23, Doi: 10.1016/j.snb. 2016.12.115, Publ. JUN 2017
[8] Bârsan, N; Tomescu, A, *Sensors and Actuators B-Chemical* Vol.: 26 Iss: 1-3 (1995) 45-48.
[9] M. Popescu, F. Sava, A. Lőrinczi, G. Socol, I.N. Mihăilescu, A. Tomescu, C. Simion, *Journal of Non-Crystalline Solids* 353 (2007) 1865–1869.
[10] M. Popescu, F. Sava, A. Lőrinczi, A. Tomescu, C. Simion, G. Socol, I.N. Mihailescu, S. Miclos, D. Savastru, *RO Patent* No. RO 123461- B1, issued on 29/06/2012.
[11] A. Lőrinczi, E. Făgădar-Cosma, G. Socol, A. Mihăilescu, E. Matei, M. Ştefan, C. Logofătu, Methane sensitive material at room temperature, *RO Patent Request* No. A/00621/29.08.2018, filed with *OSIM.*

Light- and voltage-controlled capacity of Cu-As_2S_3-Cu thin film cells for photodetection

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Amorphous As_2S_3 thin films have remarkable electrical and optical properties, which make them solid candidates for a variety of applications and keep up the scientific interest to study them, even after decades from the first results [1]. This composition has its optical absorption edge around the 500 nm, and shows a high optical transmission in the infrared (IR) and mid-infrared (MIR) spectral domain [2]. From structural point of view, a-As_2S_3 has a quite sparse network, able to accommodate certain ionic or atomic species [2].

The behaviour of thin a-As_2S_3 film deposited onto a thin Ag layer, and illuminated with 532 nm wavelength green laser light has already been studied. These bi-layer structures change their structural and optical properties upon illumination with this monochromatic green light [2, 3]. In many technological solutions there is a tendency to substitute silver with copper.