The effect of the elemental composition of the spray-solution on the properties of SnS thin films

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SnS thin films are characterized by the direct band optical transitions during light absorption, the optical band gap of 1.3 eV, which can be slightly be changed depending on the dposition conditions and by the large value of the absorption coefficient (>10^4 cm^{-1}). Due to this the SnS thin films are considered as promising candidats for the fabrication of high efficient solar cells [1]. The wide availability of tin and sulfur in combination with the low-cost fabrication technology, for example the spray pyrolysis teqnique, allow the fabrication of low cost solar cells.

The deposition of the SnS thin films was carried out by the spray pyrolysis method using the 0.1 M aqueous solutions of tin tetrachloride $SnCl_4$ · 5H2O, tin dichloride $SnCl_2$ · $2H_2O$ and thiourea $(NH_2)_2CS$, which are mixed before the spray pyrolysis process in proportions that provide the excessive sulfur content in the solution in order to prevent its vacancies in the thin films due to the evaporation at high temperature. The best structural perfection and adhesion were obtained at the volume ratio of the solutions $SnCl_4{\cdot}5H_2O$ ($SnCl_2{\cdot}2H_2O$) : $(NH_2)_2CS$ = 1 : 3. The spraying of the solution was carried out at the velocity of 2-3 ml/min by means of compressed air onto glass and glass-ceramics substrates. The spraying of 25 ml of the solution allowed to obtain 0.5-0.6 um thick films for the $SnCl_4{\cdot}5H_2O$-based solution and 0.1-0.3 um thick films for the $SnCl_2{\cdot}2H_2O$-based solution. The substrate temperature during the deposition process was set from 250 to 350 ^oC.

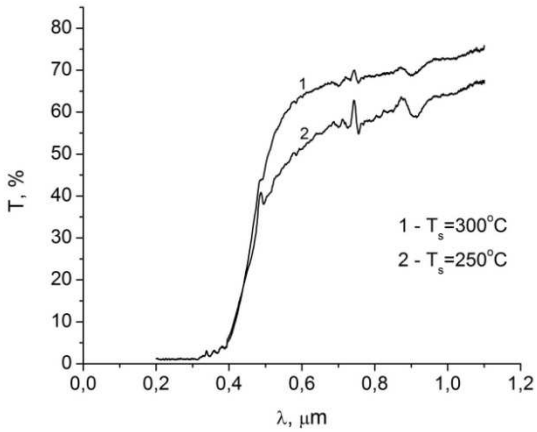

Fig. 1. The transmittance spectrum of the SnS films prepared from the $SnCl_4{\cdot}5H_2O$-based solution.

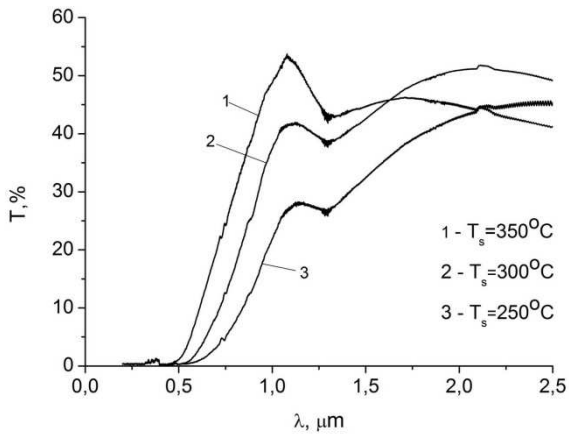

Fig. 2. The spectral distribution of the SnS films prepared from the $SnCl_2{\cdot}2H_2O$-based solutions.

Fig. 1 and 2 show the spectral distributions of the transmittance coefficient of the SnS thin films prepared at different substrates temperatures. The thin films prepared from the $SnCl_4{\cdot}5H_2O$-based solution can be used as a window material and the thin films prepared from the $SnCl_2{\cdot}2H_2O$-based solution can be used as an absorber material in solar cells.

[1] Jiaxiong Xu, Yuanzheng Yang, *Energy Conversion and Management* **78,** 260 (2014).