THE EFFECT OF TARTARIC ACID IN THE DEPOSITION OF \( \text{Sb}_2\text{S}_3 \) FILMS BY CHEMICAL SPRAY PYROLYSIS

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Chemical bath deposited \( \text{Sb}_2\text{S}_3 \) film has been used as absorber in extremely thin absorber solar cells [1]. Here, \( \text{Sb}_2\text{S}_3 \) films were chemically sprayed by atomising aqueous spray solution, consisting of \( \text{SbCl}_3 \) (\( \text{Sb}=2 \text{ mmol/L} \)), thiourea (S) and tartaric acid (TA) in molar ratios of \( \text{Sb}:\text{S}:\text{TA}=1:3:10 \) (as utilised in [2,3]) or 1:3:1, onto preheated glass substrates. The growth temperature (T) varied 205°C-230°C and 205°C-355°C for \( \text{Sb}:\text{S}:\text{TA}=1:3:10 \) and 1:3:1, respectively. Effects of TA concentration in spray solution, growth temperature and annealing temperature on the film properties were studied with X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX) and Fourier transform infrared spectroscopy (FTIR). Additionally, thermogravimetric and differential thermal analysis (TG/DTA) of TA was carried out.

\( \text{Sb}_2\text{S}_3 \) film grown at 205°C from solution with \( \text{Sb}:\text{S}:\text{TA}=1:3:10 \) is ca. 1 µm thick, contains orthorhombic stibnite (\( \text{Sb}_2\text{S}_3 \)) phase and high amount of carbon and oxygen residues. Reduced TAs concentration of 1:3:1 in spray solution leads to orthorhombic \( \text{Sb}_2\text{S}_3 \) film with decreased carbon and oxygen content in the film compared to solutions with \( \text{Sb}:\text{S}:\text{TA}=1:3:10 \). Increasing T from 205°C to 355°C decreases the mean crystallite size from 25 nm to 15 nm while a decrease in sulphur and an increase in oxygen content are detected. According to SEM, the morphology and the thickness of \( \text{Sb}_2\text{S}_3 \) film grown from \( \text{Sb}:\text{S}:\text{TA}=1:3:1 \) are heterogeneous and film thickness decreases with increasing T. FTIR spectra of \( \text{Sb}_2\text{S}_3 \) film substance confirm that the used T is insufficient for the TA to decompose. According to the TG/DTA, TA decomposition takes place in three steps where 95% of mass is lost by 254°C and TA is totally decomposed at 495°C. Innovatively, \( \text{Sb}_2\text{S}_3 \) films with \( \text{E}_\text{g}=1.7 \text{ eV} \) were sprayed from alcohol solvents.

References

1. S.J. Moon et al., 2010, *J. Phys. Chem. Lett.* 1, 1524