RAMAN ASSISTED STUDY OF THE IMPACT OF ANNEALING TEMPERATURE FOR THE FORMATION AND STRUCTURE CHANGES FOR TIN SULFIDE FILMS

Boldizsár Zsiros[1], Ieva Barauskiene[2], Attila Farkas[1], Ingrida Ancutiene[2], Asta Bronusiene[2]

[1]Budapest University of Technology and Economics
[2]Kaunas University of Technology
assta09@gmail.com

In recent years, nanostructured semiconductors have gained significant interest due to their high potential application in electronic, optical, and semiconductor devices. The fundamental properties of these nanostructured materials depend on their architectures, including geometry, morphology, and hierarchical structures [1,2]. Metal sulfides are one of the most important semiconductor materials that can be made using many different synthesis routes. Solution based synthesis has many advantages, such as being inexpensive, having short duration. Moreover, the application of abundant non-toxic components allows to reduce energy consumption indirectly through a simpler waste treatment or more efficient processing of raw materials with less CO2. A successive ionic layer adsorption and reaction (SILAR) method is one of the chemical methods for making uniform films. The obtained thin films were characterized using Raman, X-Ray diffraction, scanning electron microscopy (SEM), and ultraviolet-visible (UV-Vis) spectroscopy. The effect of annealing temperature on the morphology and phase of tin sulfide has been investigated. In this work, ascorbate stabilized tin sulfide on the fluorine doped tin oxide (FTO) glass slides was synthesized by an eco-friendly and low-waste SILAR process. The main aim of the process is to immerse the substrate into two separately placed precursor solutions, then wash with distilled water in order to wash loosely bounded ions. To improve the solubility of tin(II) chloride in distilled water, environmentally-safe and biodegradable L-ascorbic acid was used as a reducing and capping agent [3]. X-Ray diffraction results showed change in the phasic composition of the deposited films. Non-annealed films consist of SnS and Sn2S3, where SnS (mineral Herzenbergite) is the dominant [3]. Moreover, Raman chemical imaging, together with X-Ray diffraction patterns, confirms phasic changes for non-annealed and annealed samples. Annealing increases the oxidation number of Sn atoms. According to Raman maps, sample annealed at 200 °C has very similar chemical properties compared to the non-annealed sample, so annealing effects are significant only at higher temperatures. Samples annealed at 300 °C are neither dominantly SnS or SnS2 containing, the proportion of the two is close to equal. Sample film annealed at 400 °C consist mostly of SnS2, higher temperature annealing cause oxidation of tin atoms. Ultraviolet-visible spectroscopy was done to calculate bandgap values of the films obtained. In this current work, a facile, eco-friendly technique to synthesize L-ascorbate acid stabilized tin sulfide thin films is described. This material is fairly cheap, environmentally clean and has interesting properties.

[1] M Salavati Niasari et al Shape selective hydrothermal synthesis of tin sulfide nanoflowers based on nanosheets in the presence of thioglycolic acid J Alloys Compd
[2] MS Fuhrer et al Crossed Nanotube Junctions Science
[3] A Bronusiene et al Effect of ascorbic acid on the properties of tin sulfide films for supercapacitor application Surfaces and Interfaces