New technologic Substrates by Electrodeposition for Energy devices: an XPS study of Cu- and Sn- sulfides

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The global environmental concerns and the increasing demand for energy, coupled with a steady progress in renewable energy technologies, are opening up new opportunities for the use of renewable energy resources. Electrodeposition is well known as a usefull technique for depositing metals and metallic alloys at the industrial level, with a wide range of applications from large area surface treatments to most advanced electronic industries. Electrodeposition of semiconducting materials represents a new challenge, not only from the scientific point of view, but also from the economic point of view, since this method exhibits interesting characteristics for large area, low cost and generally low temperature and soft processing of materials.

In this study, the Electrochemical Atomic Layer Epitaxy (ECALE) method has been used to obtain binary compound semiconductors such as Cu_xS and Sn_xS_y on Ag(111). The amount of the elements deposited in the first layers of the compounds was determined by the oxidative stripping of cations, followed by the reductive stripping of anions.

Due to the fact that the sulfide is formed only after deposition of atoms in their elemental state, the valence state and the effective metal-to-anion ratio were studied through X-ray Photoelectron Spectroscopy (XPS), a technique able to gain this information even on very thin films of deposited chalcogenide.

Preliminary XPS characterisation of the Cu_xS film reveals Cu to occur in his formally monovalent state and the ratio Cu/S to be approximately 1:1. Accordingly, a preliminary attribution to the crystal structure of covellite, CuS, is proposed for the depositated chalcogenide. XPS characterisation of the Sn_xS_y compound, indicates that the layers are self-arranged towards the layered crystal structure of berndtite, SnS_2. This evidence allows to set up fundamental information on how control the layer-by-layer deposition.

Moreover, this study reviews the state of art of the literature concerning the knowledge of the binary Cu-S and Sn-S systems, while shedding light on the possible development on the ternary Cu-Sn-S system, and it sets up perspectives for photovoltaic applications. Chalcogenide materials are of considerable interest as the promising semiconductor for electro-optic devices, thermoelectric devices and optical recording media.