SnS by Ionized Jet Deposition for photovoltaic applications

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**Introduction**

Tin sulfide is an excellent candidate for the mass production of solar cells as it is composed of abundant and not toxic elements. In this work we present SnS polycrystalline films deposited by a novel Ionized Jet deposition (IJD) technique. IJD is a technique in which a pulsed high power electron beam penetrates into the target resulting in a rapid evaporation of the material, and its transformation in plasma state. Solar cells have been fabricated in superstrate configuration and the SnS layer has been deposited on top of a glass/TCO/CdS structure. Substrate temperatures between room temperature and 400 °C have been experimented for the SnS deposition and films have been characterized and compared by AFM microscopy and X-ray diffraction. Complete solar cells have been analyzed by J-V measurements.

**Ionized Jet Deposition System**

The IJD method is based on the ionization of a gas stream flowing through a metallic nozzle, which serves simultaneously as the auxiliary electrode for the plasma discharge ignition. A pulse at high voltage (up to 25 kV) and a short duration (less than 1 µs) is applied to the cathode. A strong ionization of the gas jet ablating the target surface results in a rapid evaporation of the target material and its transformation in plasma phase.

**AFM morphology**

For substrate temperatures lower than 200 °C the IJD SnS film tends to delaminate, while over 200 °C they become more adhesive and compact.

At 300 °C, grains become smaller, but they are more dense and packed as the substrate temperature increases.

At 400 °C the surface of the SnS film is very smooth and it is even smoother than the equivalent film deposited by thermal evaporation [1].

**X-Ray Diffraction**

The main reflections, also detected for evaporated-SnS, such as (010) and (111) are observed and very few other peaks are revealed. No secondary phases are detected demonstrating a good quality in terms of homogeneity and uniformity.

**Solar cell performance**

Preliminary solar cells show photovoltaic parameters of about $J_{sc} = 2.1$ mA/cm², $V_{oc} = 0.12$ V, FF = 31% and $\eta$ of 0.08%.

**Conclusions**

SnS thin film layers have been fabricated for the first time by an improved technique of electron pulsed deposition called ionized jet deposition. Comparison between AFM morphology of IJD-SnS layers, deposited at different temperatures, shows the good quality of layers at 300°C temperatures. XRD patterns show that the IJD- layers grown at any temperature between 200°C and 400°C seem not to have secondary phases. These results are promising for optimizing a low-substrate temperature deposition process. Preliminary solar cell devices show the formation of p/n junction even if efficiencies are still below 1%.

Higher efficiencies are expected by improvement of the p/n junction with the application of a more suitable buffer layer (i.e. Zn(S,O) instead of CdS) [2].

**References**


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