



**"Gheorghe Asachi" Technical University of Iasi, Romania**



---

## **COPPER SULFIDES THIN FILMS WITH CONTROLLED PROPERTIES FOR PHOTOVOLTAIC CELLS**

**Luminita Isac\*, Ionut Popovici, Alexandru Enesca, Anca Duta**

*Transilvania University of Brasov, Renewable Energy Systems and Recycling Department, 29 Eroilor Blvd., 500036 Brasov, Romania*

---

### **Abstract**

Films of  $\text{Cu}_x\text{S}$  with 430-700 nm thickness were deposited by robotic spray pyrolysis technique, at  $T = 300^\circ\text{C}$ , using 90 spraying sequences, from water:ethanol:glycerol = 7:2:1 (in volumes) solutions with a molar ratio  $\text{Cu}:\text{S} = 1:2.5-3.5$ . Relative dense, homogenous and uniform films of  $\text{Cu}_x\text{S}$  ( $x = 1.8-2$ ), with  $E_g = 1.97-2.49$  eV and exhibiting electric resistance behavior were obtained. The as-deposited films were annealed in air or in sulfur atmosphere, at  $300^\circ\text{C}$ , for one hour. Dense and uniform films, containing  $\text{Cu}_2\text{S}$  crystalline phase, with  $E_g = 2.16$  eV and *p*-type semiconductor electrical behavior, were obtained by annealing in air of films deposited from precursors' solutions with  $\text{Cu}:\text{S} = 1:3$  at  $\text{Cu}^{2+}$  concentration of 3.5 mol/L.

*Key words:* copper sulfides, photovoltaic cells, robotic spray pyrolysis, thin films

*Received: April, 2011; Revised final: September, 2011; Accepted: September, 2011*

---

---

\* Author to whom all correspondence should be addressed: e-mail: [isac.luminita@unitbv.ro](mailto:isac.luminita@unitbv.ro); Phone: +40744237621