FORMATION OF COPPER SULFIDE LAYERS ON POLYPROPYLENE BY CBD METHOD

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INTRODUCTION

Nanocrystalline copper sulfide (Cu_xS), deposited as a thin film on the different substrates, is considered to be a promising material for solar energy conversation systems, because of its structural and electrical properties. One of the interesting semiconducting layers is copper sulfide because of its metal-like electrical conductivity, chemical-sensing capability, and ideal characteristics for solar energy absorption. Consequently, polymers modified with copper sulfide layers are used as conductive substrates for deposition of metals and semiconductors; as gas sensors functioning at temperatures tending to room temperature; in thermoelectric applications; in solar cells; in lithium ion batteries [1].

The aim of the work was to characterize the surface of the PP/Cu_xS composite by scanning electron microscopy (SEM/EDX) and to measure the sheet resistance.

EXPERIMENTAL

This work reports the preparation of Cu_xS electroconductive layers on polypropylene films (150 µm thicknesses (KWH Plast, *Finland*) using the CBD method at room temperature [2,3].

The etching solution H_2SO_4/H_3PO_4 (1:1) saturated with CrO_3 (90 °C, 25 min) was used for the oxidation of the surface of PP.

The deposition of the Cu_xS thin films was carried out at room temperature using a mixture of 0.05 M $CuCl_2$ and 0.05 M $Na_2S_2O_3$ solutions (pH 3) for 16 h. The deposition process was carried out by repeating such deposition cycles 3 times.

The films were annealed at 80 °C for 30 minutes in air atmosphere.

Samples of the PP/Cu_xS composite were investigated by SEM/EDX, and electrical sheet resistivity was measured using special electrodes.

RESULTS

The room temperature electrical resistivity of the formed layer after 1st deposition cycle was about 10 kΩ/□, after 2nd – 180 Ω/□, and after 3rd – 130 Ω/□. After annealing electrical resistivity decreased to 7 kΩ/□, 170 Ω/□ and 110 Ω/□ accordingly.

Analysis of SEM images of PP/Cu_xS films showed that after 3 deposition cycles, the PP substrate was completely covered by Cu_xS particles. Cross sectional image given in Fig. demonstrated growing of Cu_xS layer with increasing of the cycle number.

EDX analysis showed that Cu_xS is formed on the surface of the PP film, and a negligible amount of copper and sulfur diffused into the PP matrix (Table and Fig.)

Table. Concentration of elements in PP/Cu_xS composite after I, II and III deposition cycles

Depth, µm	Element Symbol	Atomic Concentration			Weight Concentration			Stoichiometric Concentration		
		I	II	III	I	II	III	I	II	III
0	C	42.05	68.46	71.96	24.76	55.97	58.53	75.30	94.80	94.56
	Cu	12.27	2.60	3.08	38.22	11.27	13.26	21.97	3.61	4.05
	S	1.52	1.15	1.06	2.39	2.51	2.31	2.72	1.59	1.40
5	C	60.33	79.77	79.50	52.24	74.01	70.44	98.70	99.49	97.69
	Cu	0.48	0.20	1.35	2.18	0.98	6.35	0.78	0.25	1.66
	S	0.32	0.20	0.53	0.73	0.51	1.25	0.52	0.26	0.65
15	Cu	0.00	1.14	1.14	0.00	0.67	0.67	0.00	0.19	0.19
	S	0.00	0.02	0.02	0.00	0.04	0.04	0.00	0.02	0.02

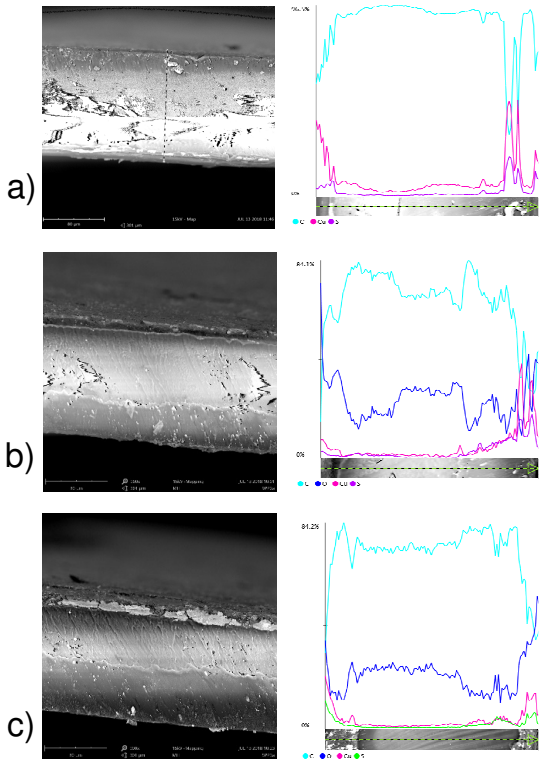

Fig. Cross section SEM images and distribution of elements of PP/Cu_xS composite formed by I (a), II (b) and III (c) cycles

CONCLUSIONS

Formed by CBD Cu_xS layers are thin, and uniform, and a small amount of Cu and S was diffused into the PP matrix.
The electrical resistivity of composites PP/Cu_xS decreased with an increasing number of deposition cycles, and, after annealing, the decrease in electrical resistivity is insignificant.

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