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Structural and optical properties of pulsed electrodeposited Ag-In alloy

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Electrodeposition produces nanoparticles with controlled characteristics namely size, morphology and composition. Electrodeposited silver based alloys find wide application from catalytic to antibacterial research due to its excellent properties. Silver-Indium (Ag-In) alloys were prepared by pulsed electrodeposition technique using different complexing agents. Boric acid was used as an additive for smoother deposition of the sample. The deposition was found to be favoured even at lower applied current density of 10 mA/cm^2. X-Ray diffraction studies (XRD) were performed to confirm the formation of alloy. Thermal stability of the Ag-In samples were analyzed through Thermogravimetric analysis (TGA). Ultraviolet-Visible (UV-Vis) spectroscopy was used to characterize the optical property of prepared samples.

Keywords: Pulsed electrodeposition, silver, indium, Ag-In alloy.

Introduction

To achieve specific properties for specific applications electrodeposition is an important technique for the synthesis of new materials in modern technology[1]. In comparison with pure silver deposits, alloy coatings of silver-indium were found to enhance tarnish resistance and antifriction properties[2].

In the present work, Ag-In alloys were prepared using different complexing agents namely ammonia and trisodium citrate and its physical properties were studied.

Experimental

Ag-In alloys were prepared using pulsed electrodeposition method and the experimental procedure was reported elsewhere[3]. The details of the experimental parameters and sample identity for the deposited Ag-In alloy were listed in Table 1.

Results and discussion

Powder X-ray diffraction (XRD) analysis was carried out using GE X-ray diffraction system XRD 3003 TT with Cuk$_{\alpha 1}$ radiation (λ = 1.5406 Å). The XRD pattern was obtained from 30° to 70° at 0.04°/s. The XRD pattern of the samples A, B, and C were shown in Fig. 1. Three phases namely $AgIn_2$, Ag_3In and Ag_9In_4 present in Sample A were matched with reference to JCPDS file number 25-0386, 65-4208 and 65-3348 respectively. Dual phases $AgIn_2$ and Ag_3In were

Table 1. Bath composition used for preparing Ag-In alloy by pulsed electrodeposition process

Sample identity	Complexing agent	Phases and XRD reflections	Experimental parameters
A	–	Ag_9In_4 33°, $AgIn_2$ 37.6°	Ag:In 50:50
		Ag_3In 38.82°	J:10 mA/cm^2
B	Ammonia	Ag_3In 37.88°, $AgIn_2$ 57.8°	pH 1
			Temperature 25°C
		$AgIn_2$ 33.2°, 36.96°, 41.34°	Surfactant – Boricacid
C	Trisodium citrate	57.68° and 66.52°	T_{ON} = 20 ms
		Ag_9In_4 38.6°	T_{OFF} = 80 ms

J* = current density.

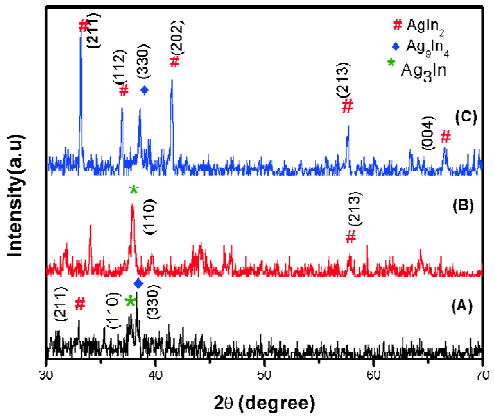

Fig. 1. XRD pattern of samples A, B and C.

present in sample B. Sample C has dual phase of $AgIn_2$ and Ag_9In_4. The phases were marked with appropriate symbols and plane values were indexed.

Optical absorption analysis: The diffused reflectance spectrum of the samples A, B and C were taken using Lambda 650 Perkin-Elmer Spectrophotometer in the wavelength ranging from 200 nm to 450 nm and were shown in Fig. 2. The absorption bands of the samples A, B and C were observed at 335 nm, 330 nm and 338 nm was attributed to the formation of Ag-In alloy which was in agreement with the previous results. Also the resonance peak of pure silver and indium were reported at 414 nm and 258 nm[4].

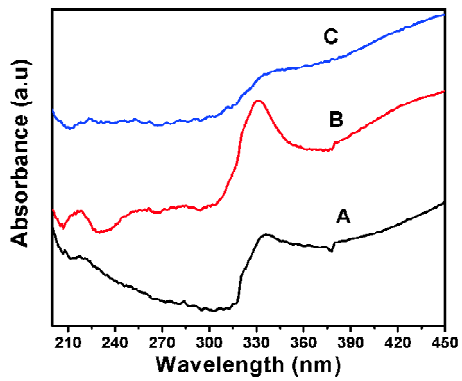

Fig. 2. UV-Visible absorption of samples A, B and C.

Thermogravimetric analysis: The thermal stability of the samples B and C were determined by instrument NETZSCH STA 2500 STA2500A-0061-N in nitrogen atmosphere at 20 K/min. Fig. 3 represents TGA thermograms of the samples

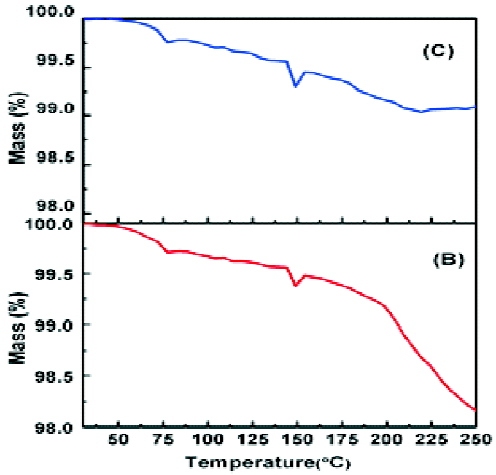

Fig. 3. Thermograms of samples A, B and C.

B and C which showed loss about 1.83% and 0.92% respectively. Weight loss observed around 77°C in the above samples were due to the removal of hydroxide and a prominent weight loss at 149°C was observed in above samples due to the phase transition of Ag_3In which is in agreement with the previous values[2,5].

Conclusion

Ag-In alloys were prepared by pulsed electrodeposition. The effect of different complexing agents has been analysed by XRD and UV-Vis studies. The thermal stability of samples has been studied upto 250°C.

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