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Morphological and Structural Characterization of Tin Dendritic Nanostructures Produced by Various Electrodeposition Processes

Jelena D. Lović[1], Nebojša D. Nikolić[1], Vesna M. Maksimović[2] and Predrag M. Živković[3]

1 University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Department of Electrochemistry, Belgrade, Serbia

2 University of Belgrade, Vinča Institute of Nuclear Science – National Institute of the Republic of Serbia Belgrade, Serbia

3 University of Belgrade, Faculty of Technology and Metallurgy, Karnegijeva 4, Belgrade, Serbia

Tin powders found wide application in many branches of the industry, such as powder metallurgy, lithium-ion battery production, electronic industry and manufacture of tin solder paste [1]. Application of Sn is based on specific features of this metal like high electrical conductivity, low electrochemical migration behavior, excellent solderability and low material cost [2]. The main methods used for synthesis of Sn in the powder forms are: gas atomization process, cementation process, chemical reduction process, and electrodeposition [1,2]. Electrodeposition is widely used method for a synthesis of metals in the powder form, since the shape and the size of particles can be easily regulated by choice of parameters and regimes of the electrodeposition [3].

In this study, Sn powders were electrodeposited from an alkaline electrolyte containing 20 g/l $SnCl_2 \times 2H_2O$ in 250 g/l NaOH at the room temperature by application of both potentiostatic and galvanostatic regimes of the electrolysis. Electrodeposition was performed at various cathodic potentials (–1185, – 1200, –1270, – 1400, – 1600 and – 1800 mV vs. Ag/AgCl), and at a current density outside the plateau of the limiting diffusion current density (–3.0 mA cm^{-2}). Morphology of Sn particles is characterized by scanning electron microscope (SEM) and crystal structure by X-ray diffraction (XRD).

The dendritic particles of various shapes and size were produced by the electrolysis processes. With increasing the applied cathodic potential, the shape of dendrites changed from the spear-like and the needle-like (Figure 1a) to the fern-like (Figure 1b) and the stem-like dendrites (Figure 1c). The various dendritic forms, including those with prismatic branches were formed by the galvanostatic regime of the electrolysis (Figure 2). Formation of various dendritic forms has been explained by correlation of the morphology of produced dendritic particles with the polarization characteristics for this Sn electrodeposition system. Irrespective of parameters and regimes of electrolysis, the XRD analysis showed that all types of dendritic particles had nanostructural features, with the average crystallite size in the range (63.1–90.3) nm [4].

References:

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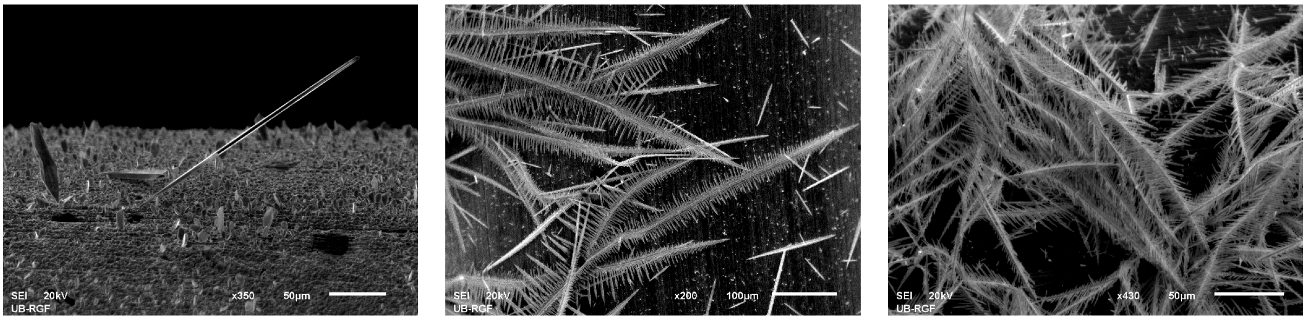
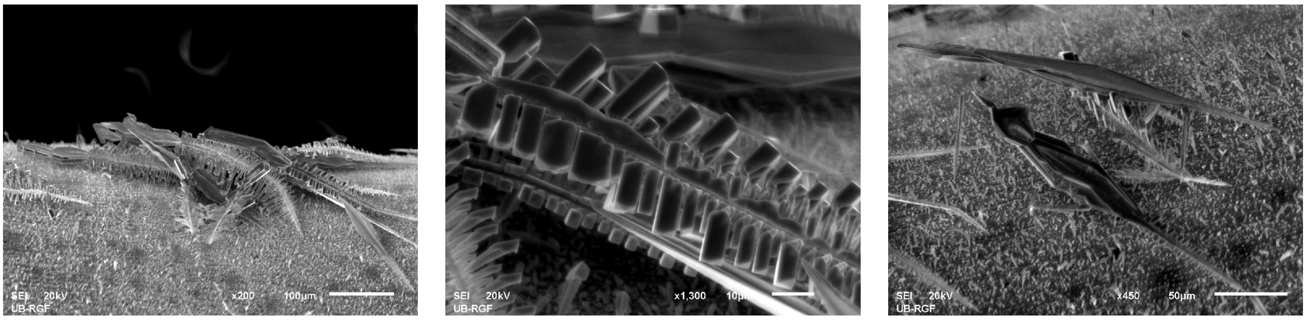
[3] K.I. Popov, S.S. Djokić, N.D. Nikolić, V.D. Jović, *Morphology of Electrochemically and* Chemically Deposited Metals, Springer International Publishing, 2016.
[4] This work was supported by MPNTR of Republic of Serbia (RS) (Grant No. 451-03-68/2022-14/200026) and Science Fund of RS (Grant No. AdCatFC: 7739802).



a) b) c)

Figure 1. Morphologies of Sn dendritic particles obtained by electrodeposition at cathodic potentials of: a) −1185 mV (the spear-like and the needle-like dendrites), b) −1270 mV (the fern-like dendrites), and c) −1800 mV vs. Ag/AgCl (the stem-like dendrites).



a) b) c)

Figure 2. Morphologies of Sn dendritic particles obtained by a galvanostatic regime of the electrodeposition at a current density of −3.0 mA cm^{-2}: a) and b) very branchy dendrite with branches of prismatic shape, and c) the spear-like dendrites.