Journal of Alloys and Compounds 552 (2013) 195–201

Contents lists available at SciVerse ScienceDirect

Journal of Alloys and Compounds

journal homepage: www.elsevier.com/locate/jalcom

Morphological and microstructural properties of two-phase Ni–Cu films electrodeposited at different electrolyte temperatures

Umut Sarac [a,*], M. Celalettin Baykul [b]

[a] Department of Elementary Education, Bartın University, Bartın 74100, Turkey
[b] Department of Physics, Faculty of Arts and Science, Eskişehir Osmangazi University, Eskişehir 26480, Turkey

ARTICLE INFO

Article history:
Received 7 August 2012
Received in revised form 15 October 2012
Accepted 17 October 2012
Available online 24 October 2012

Keywords:
Electrodeposition
Ni–Cu films
Electrolyte temperature
Surface morphology
Microstructural properties
Texture

ABSTRACT

In this study, Ni–Cu films are grown on ITO (indium tin oxide) coated glass substrates by electrodeposition technique at various electrolyte temperatures, and then surface morphology and structural properties have been studied in detail. The X-ray diffraction (XRD) patterns revealed the existence of Cu-rich and Ni-rich phases in the Ni–Cu films. Besides, microstructural parameters such as crystallite size and crystallographic texture were also calculated from the XRD patterns. Compositional analysis on the Ni–Cu films carried out using energy dispersive X-ray spectroscopy (EDX) indicated that the Cu content within the film increases with increasing electrolyte temperature. Scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used to investigate the surface morphological structure of Ni–Cu films. It was found that the surface morphology of Ni–Cu films exhibits a strong dependence on the temperature of the electrolyte. It was also found that the surface roughness of the Ni–Cu films increases with increasing electrolyte temperature. The texture aspect parameter and texture direction index were obtained for isotropy/anisotropy surface texture. For all Ni–Cu films deposited at different electrolyte temperatures, the surface texture was found to be isotropic.

1. Introduction

Electrodeposition of Ni–Cu films received growing interest in recent years due to their interesting functional properties such as good corrosion resistance, anti-biofouling, and electrocatalytic properties, as well as their reasonably good wear resistance [1–4]. They are widely used in various sea water applications, such as fittings condenser, valves, and heat exchanger tubes [5]. Furthermore, Ni–Cu films find applications in the preparation of nanostructured materials for industrial and electronic applications, such as notebooks and mobile phones [1,6,7]. They exhibit either paramagnetic or ferromagnetic behavior depending on their composition [2,8,9]. Thus, Ni–Cu films with ferromagnetic behavior are used in magnetic sensors and actuators, however, the nonmagnetic compositions of them are utilized as nonmagnetic gap in recording write heads [2].

The electrodeposition technique is extensively used in production magnetic thin films due to distinct advantages such as low cost, minimum waste of components, rapid production, and simplicity [10–16]. In the electrodeposition process, film properties were substantially affected by many deposition parameters including current density, deposition potential, electrolyte concentration, electrolyte pH, control methods, additives, and electrolyte temperature [3,7,17,18]. On the other hand, it is essential that the substrates used for the electrodeposition of films are conductive [19,20]. Although ITO is not a classical substrate compared to metallic substrates like stainless steel, copper, brass, gold, etc., which exhibit metallic conductivity, it is well known that ITO is an excellent transparent and conductive substrate for a wide range of material thin films [21,22]. Especially, ITO substrates are almost non-sensitive to external air and humidity [23]. Therefore, these advantages make them very applicable. Many researchers such as Saitou et al. [24,25], Gomez et al. [26] and also Nzoghe-Mendome et al. [23] successfully used this substrate in the electrodeposition of Ni and other metals. On the other hand, ITO substrates were also successfully used in our previous studies [27,28]. Therefore, in this study, Ni–Cu films have been also electrodeposited onto ITO coated glass substrates.

AFM measurements give a detailed information on the surface morphology of thin films [29]. Material properties such as resistivity, scattering, and electron mobility are influenced also by the surface roughness of electrodeposited films [30]. Therefore, to obtain a crack-free and continuous surface of Ni–Cu films requires a detailed study on the evolution of surface morphology and the role of electrolyte temperature.

Although it is well known that the electrolyte temperature affects the properties of electrodeposited films, to our best knowledge, there is no sufficient work on the effect of electrolyte

* Corresponding author. Tel.: +90 (378) 223 51 94; fax: +90 (378) 223 52 08.
E-mail address: usarac428@hotmail.com (U. Sarac).

0925-8388/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jallcom.2012.10.071