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ORIGINAL PAPER

Differences Observed in the Phase Structure, Grain Size–Shape, and Coercivity Field of Electrochemically Deposited Ni–Co Thin Films with Different Co Contents

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Abstract Nanostructured Ni–Co thin films were produced using galvanostatic electrodeposition on indium tin oxide (ITO)-coated glass substrates from an aqueous electrolyte solution without stirring at ambient temperature. Different compositions of the films were achieved depending on the Co ion concentration within the electrolyte. From the compositional analysis performed using energy dispersive X-ray (EDX) spectroscopy, the anomalous codeposition was found for all films and an increase in the Co content of the films was observed with increasing Co ion concentration within the electrolyte. The X-ray diffraction (XRD) analyses revealed that the phase structure of the electrodeposited Ni–Co thin films changes from single face-centered cubic (FCC) to a mixture of FCC and hexagonal close-packed (HCP) with the Co content within the films. It was also observed that the mean crystallite size estimated by applying the Scherrer method gradually decreases as the Co content within the films increases. The scanning electron microscopy (SEM) employed for the surface morphology showed that the size and shape of the grains formed on the film surface are strongly dependent on Co content within the films. Magnetic measurements performed by vibrating sample magnetometer (VSM) revealed that the films with different Co contents exhibit different magnetic properties; the Co-rich film has much higher coercivity field when compared with the Ni-rich film.

Keywords Ni–Co thin films · Microstructure · SEM · Co ion concentration · Coercivity field

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1 Introduction

Electrodeposition of magnetic thin film systems has gained an increasing interest in recent years, and therefore many studies have been carried out by researchers. It is well known that the magnetic thin films based on iron group metals such as Fe, Co, and Ni possess much better permanent magnetic properties than pure metals [1, 2], and the addition of cobalt in electrodeposited nickel is known to develop their properties [3, 4]. Electrodeposited Ni–Co thin films with different compositions have potential applications in microelectrical mechanical system (MEMS) and several other industries due to their unique properties such as magnetic, high heat conductivity, good wear resistance, high hardness, and electrocatalytic activity [5–9]. In addition, Ni–Co films also find applications for the traditional protective and decorative purposes [2, 10]. In the present study, Ni–Co thin films have been grown by electrodeposition technique. Among all the synthesis techniques developed for fabrication of Ni–Co films, electrodeposition technique has excellent characteristics such as simplicity and low cost to fabricate Ni–Co films without high temperature and pressure [2, 8, 11, 12]. The coercive field of electrodeposited films is one of the most interesting magnetic properties [13]. It was reported that not only chemical composition, but also microstructural and morphological properties such as structure, crystallographic defects, internal stress, surface roughness, texture, grain shape, and grain size influenced