

International e-Conference on Recent Trends in Nano-Materials and Its Applications-2021 In Association with International Journal of Scientific Research in Science and Technology Volume 9 | Issue 2 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Structural and Wettability Study of Electrodeposited NiO Thin Film

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ABSTRACT

In the present paper, nickel Oxide (NiO) thin film has been synthesized by galvanostatic electrodeposition method. The crystal structural and surface wettability study of NiO thin film was carried out using X-ray diffraction (XRD) study and contact angle meter techniques. The XRD study reveals the cubic crystal structure of NiO thin film. The surface wettability study shows NiO thin film is hydrophilic in nature.

I. INTRODUCTION

Nickel Oxide (NiO) is asemiconducting oxide material having wide band gap lies between the ranges of 3.6 eV to 4 eV [1-2]. Nickel oxide (NiO) thin film have received great interest due to good electronic, optical and magnetic properties with high chemical stability. Due to these features it is used in variety of potential applications such as, fuel cell [3], gas sensors[4], solar thermal absorbers[5], photodetectors [6], batteries [7] and catalyst [8].

The NiO thin film have been synthesized by different physical and chemical methods such as, chemical bath deposition method [9], sputtering method [10], sol-gel method [11], chemical vapor deposition method [12], pulsed laser deposition [13]. The electrodeposition method is one of the best suitable method for deposition of metal on electrode substrate. Because it is cheap, easily available, and give thin, uniform film on substrate. In the present work, NiO thin film has been synthesized by potentiostatic electrodeposition method. The structural and surface wettability study of NiO thin film was carried out with the help of characterized by X-Ray diffraction (XRD) and surface wettability study.

II. EXPERIMENTAL DETAILS:

2.1 Substrate Cleaning

Substrate cleaning is a most important part in the deposition of thin films. If the substrate surface is contaminated, the resulting films can be non-uniform. Electrically conducting substrate is the necessary requirement of electrodeposition. These substrates were cleaned using following procedure:

- 1) The substrates were mirror polished using zero grade polish paper.
- The substrates were washed with detergent and double distilled water,

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 Finally, the substrates were dried, degreased in AR grade acetone and were kept in dust free chamber.

2.1.2 Synthesis of Nickel Oxide (NiO) Thin Films:

Nickel Oxide (NiO) thin films preparation was performed using a two-electrode system. Graphite sheet was served as counter electrode. Stainless steel substrate was used as working electrode. For electrodeposition bath of Nickel oxide thin film was prepared by AR grade chemicals using double distilled water. For synthesis of Nickel Oxide (NiO) thin film electrode, we have used 0.2M Nickel nitrate aqueous solution. Nickel Oxide (NiO) thin film electrode was deposited potentiostatically on stainless steel (SS) substrates with constant potentials of 1.9 V for 20 minutes and then Nickel hydroxide was formed. For oxidation of nickel, the films were annealed at 400°C for one hour. This oxidized film was used for further characterization.

III. RESULTS AND DISCUSSION

3.1 X-ray diffraction study:

X-ray diffraction is a powerful technique to identify the crystal structure of the electrode materials. Fig.1 shows the XRD pattern of the film on to the stainless steel substrate with 2θ range of 20 to 80°. The XRD pattern of the film revealed the formation of NiO with cubic crystal structure. The main peaks are indexed at (2θ) 37.37° (111), 43.6°(200) and 62.94° (220) reflections which are in good agreement with the standard diffraction pattern of NiO cubic structure (JCPDS card no. 47-1049). In addition with this, peaks originated due to stainless steel substrate are indicated by 'SS'. Justin et al have reported similar kind of crystal structure for NiO material prepared by hydrothermal method using organic surfactants as templates [14].



Fig.1 : X-ray diffraction study of NiO thin film.

3.2 Surface Wettability study:

Surface wettability study of the electrode was carried out with the help of water contact angle measurement with water as liquid drop.



Fig.2 : contact angle of NiO thin film

The surface wettability study of film determines its ability to interact with ions when dipped into electrolyte, which is determined by measuring the contact angle with liquid electrolyte. Surface wettability of NiO thin film was studied by measuring contact angle. Fig.2 indicates the actual photograph of contact angle with film surface. The measured angle for NiO thin films is 34°. In this study, it is observed that the NiO thin films are hydrophilic in nature and contact angle for NiO decreases with increase in deposition cycles. The hydrophilic nature of film surface allows more interaction of electro active sites of NiO thin film.

IV.CONCLUSION

In the present report, we have synthesized nickel oxide (NiO) thin film on stainless steel substrates by economical using simple and potentiostatic electrodeposition method. The crystal structure and wettability study was carried out by using x-ray diffraction (XRD) and water contact angle measurements. The XRD study shows cubic crystal structure of electrodeposited NiO thin films. The surface wettability study shows NiO thin films are hydrophilic in nature.

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