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Sol-gel spin coated nickel oxide (nio) thin films

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ABSTRACT

The nickel oxide (NiO) thin film was prepared by Sol-Gel Spin coating method on FTO glass substrate by using the Nickel chloride as a precursor. The films were annealed at 773 ^{0}K in air for 30 min to remove hydroxide phase. Structural analysis studied by XRD with 2θ range of 10^0-80^0. The observed main peaks are at (2θ) 37.230 (111), 43.25^0 (200), 63.04^0(220) and 75.50^0(311) reflections which are matched with the standard diffraction pattern of NiO cubic structure. The average value of particle size is about 43 nm. The surface morphology of the film is observed by field emission scanning electron microscope (FESEM)shows that glass substrate is well covered with NiO material with a porous network of micro granules which is beneficial for electrolyte penetration into the film structure which increase the electrochromic performance.

KEYWORDS: Sol-Gel Spin coating method, XRD, FESEM.

INTRODUCTION

Electrochemical capacitors also recognized as super capacitors, derives their energy storage capacity from interaction between electrode and electrolyte at the interfacial region (Jagadale *et al.*, 2013). Being a prominent area of research for energy storage devices supercapacitors are disparately used as they have high power density, long cycling life, and short charging time. Moreover when compared with dielectric capacitors, supercapacitors have higher energy density. Even for high-power applications of rechargeable batteries, industrial mobile equipment and hybrid/electric vehicles supercapacitors can be used either alone as a primary power source or as a supportive endorsement. By the last decade transition metal oxides have attracted researcher to pay more attention due to their low power consumption, high efficiency. Physical methods like film coating/deposition are commonly adopted for NiO film deposition. Film coating by low-cost sol–gel combined with dip coating technique is an alternative method (Sutrave *et al.*, 2012). In the present work, NiO thin films were deposited using sol– gel coating method from nickel chloride precursor and electrochromic properties were studied and are reported in this paper. Being a transition metal oxide Nickel oxide (NiO), is a captivating material for magnetic and electrochromic applications. Being cheaper than RuO_2 as well as non polluting nature and degradability Nickel oxides (NiO) are more frequently used in lithium batteries,fuel cells, electrochromic films, gas sensors, and electrochemical supercapacitor (Dalavi et al. 2013). The aim of this work is to develop Nickel oxide thin films for application in advanced supercapacitors with a cost-effective sol-gel spin coating deposition technique.

EXPERIMENTAL TECHNIQUE The solution was prepared by using analytical reagent chemicals in double distilled water. NiO thin films had been prepared by a sol-gel spin coating technique using Nickel Chloride as a precursor. Fig. 1 shows the flow chart of deposition. In this experiment, 0.1 M Nickel Chloride solution was prepared in double distilled water.5 ml of Isopropyl alcohol was added then the solution was continuously and thoroughly stirred for 2 hours by magnetic stirrer. The gel was formed after aging the solution for 24 hours at room temperature.(Joshi *et al.*, 2016).The FTO coated transparent conducting glass having the sheet resistance of 10-15 Ω/cm^2 washed with doubledistilled water in an ultrasonic bath for about 15 min again washed with distilled water. And then the gel was deposited on FTO coated glass plate by spin coating unit. The sample was then rotated about 3000 rpm and films were annealed at 500°C for 30 min (Vidhyadharan *et al.*, 2014). The nickel oxide films were transparent with gray in color.

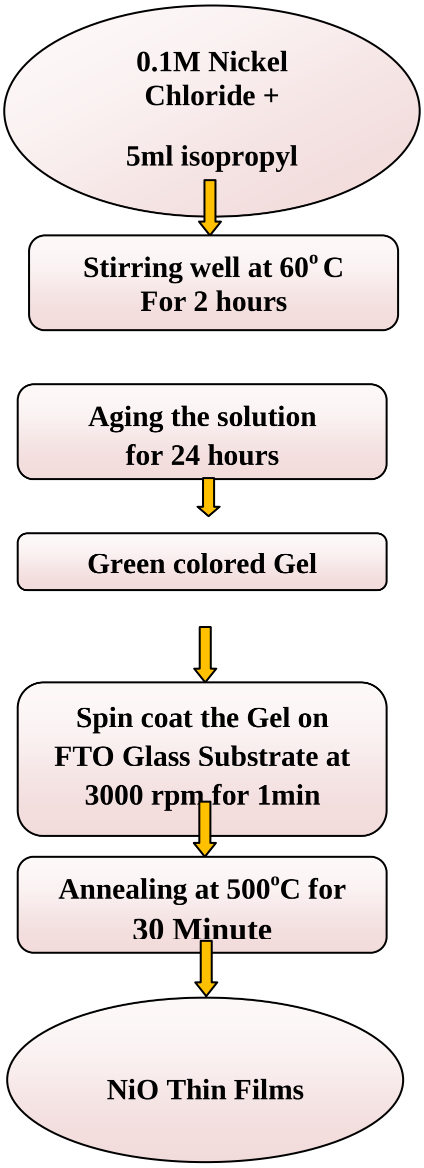

Fig 1: Flow chart of thin film preparation by the sol–gel spin coat route

STRUCTURAL ANALYSIS

The phase structure and purity of the production was examined by XRD as represented in Fig.2with 2θ range of 30-80°. The main peaks present at (2θ) 37.23 (111), 43.25 (200), 63.04 (220) and 75.50 (311)reflections which are matched with the standard diffraction pattern of NiO cubic structure (JCPDS data card 04-0835) (Macdonald., 2014). The analysis of diffractogram is shown in table 1. The average value of particle size can be calculated withScherer's formula. The average crystalline size of the particle is about 43nm at (200) plane. The lattice parameter of NiO thin film is a = 4.08Å this result is similar to Yadav *et al.*, (2016).

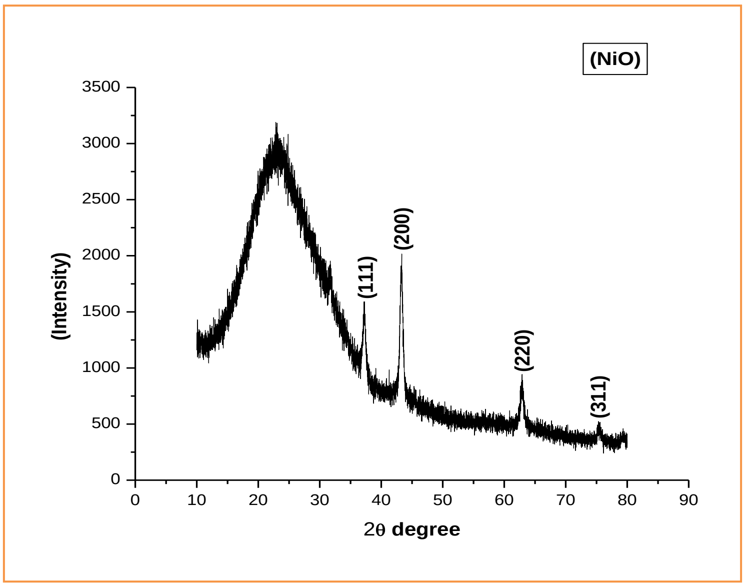

Fig 2: The X-ray diffractogram of NiO thin film deposited on FTO glass

Table 1: XRD analysis of NiO thin Film

Film	2θ In degree	Plane (hkl)	Observed'd' Å	Standard'd' Å
NiO	37.31	(111)	2.4122	2.4092
	43.34	(200)	2.0895	2.0873
	62.82	(220)	1.4775	1.4755
	75.40	(311)	1.2591	1.2598

SURFACE MORPHOLOGY: Surface morphology of NiO thin films deposited on Fluorine doped Titanium Oxide (FTO) glass substrates bysol-gel spin coating technique is studied by using FESEM. The resultant morphology observed under microscopy is shown in Fig 3. It is observed that the glass substrate is well covered with NiO material with a porous network of micro granules which is beneficial for electrolyte penetration into the film structure which increase the electrochromic performance.In supercapacitors, increased amount of charge can be stored on the highly extended surface area created by large number of pores.Nanocrystalline and porous materials as electrode material exhibit good electrochemical performance because these materials possess both a high surface area and pores These results are similar to (Patil *et,al.*, 2008).

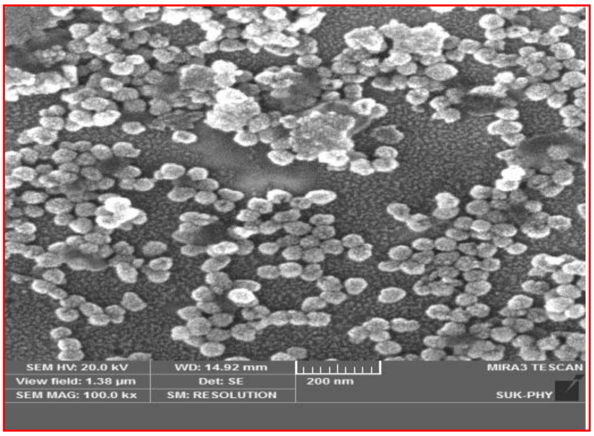

Fig 3: The FESEM of NiO thin film deposited on FTO glass

CONCLUSION

The thin films of nickel oxide with cubic structure were successfully deposited on FTO by sol- gel spin coating method by using Nickel chloride as a precursor. The deposited Film is well adherent to FTO glass substrate. The FESEM images shows the glass substrate is well covered with NiO material with a porous network of micro granules which is beneficial for electrolyte penetration into the film structure which increase the electrochromic performance.

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