International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN : 0974-4290
Vol.6, No.3, pp 1991-1993, May-June 2014

ICMCT-2014 [10th – 12th March 2014]
International Conference on Materials and Characterization Techniques

Structural and Morphological properties of Ruthenium oxide Thin Films deposited by Sol-Gel Spin coating

D. S. Sutrave[1]*, P. S. Joshi[2], S. D. Gothe[3], S.M. Jogade[1]

[1]D.B.F. Dayanand College of Arts and Science, Solapur, Maharashtra, India
[2]Walchand Institute of Technology, Solapur, Maharashtra, India
[3]Sangameshwar College, Solapur, Maharashtra, India

***Corres. author: sutravedattatray@gmail.com, preetij12@gmail.com,**

Abstract: In present investigation ruthenium oxide (RuO_2) were readily synthesized on steel substrate annealed at a temperature of 900^0C from $RuCl_3.xH_2O$ via sol-gel spin coating process. The XRD pattern showed diffraction peaks indicating tetragonal phase of ruthenium oxide. The SEM images of ruthenium oxide thin films showed total coverage of thin films. The thin film had a dense layer covered by agglomeration of particles forming a porous structure. At higher magnification (X 10,000) a porous structure of ruthenium oxide was observed.
Keywords: Thin Film, Ruthenium oxide, Sol-gel Spin coating, Surface morphology.

1. Introduction and Experimental:

Ruthenium oxide is superior due to the unique combination of characteristics, such as metallic conductivity, high chemical and thermal stability, catalytic activities, electrochemical redox properties, highly reactive with reducing agents due to its oxidizing properties and field emitting behaviour etc. [1]. It has been widely used in supercapacitor because of its good catalytic properties [2]. Ruthenium oxide thin films have been prepared using various techniques, including organometallic chemical vapour deposition [3], sol gel [4], electro deposition [5]. Here, attempts are made to deposit RuO_2 thin films using sol-gel spin coating deposition technique. Their structural and surface morphological properties had been studied.

1.1 Deposition of RuO_2 Thin Films:

RuO_2 thin films had been synthesized by a sol-gel spin coating technique using ruthenium trichloride as a source of Ruthenium oxide. In a typical experiment, 0.01 M solution of ruthenium trichloride was prepared. To obtain homogeneous solution a magnetic stirrer was used. After aging for 24 hours a gel was formed and then deposited on steel substrate by Spin coating unit. The sample was then rotated about 3000 rpm and films were annealed at a temperature of 900°C for 3 minutes. The deposition was repeated for number of time to increase the thickness of the film.

2. Results and Discussions:

2.1 Structural Characterization:

The as deposited films were uniform, well adherent to the substrate and black in colour.

Film crystallinity was analyzed using X-ray diffraction. The XRD patterns of RuO_2 films on to the stainless steel substrate are shown in figure 1. The sharp intense peaks confirm the crystalline nature and tetragonal structure of the ruthenium oxide (JCPDS Card Number 65-2824) .These results are consistent with the results obtained by M. Khorasani-Motlagh, M. Noroozifar, M. Yousefi et.al.[6] The peaks having star mark corresponds to stainless steel. Table 1. gives the details of calculated and standard 'd' values and planes of RuO_2 deposited thin films. The obtained values for the lattice parameters are a=b= 4.5200 A^o and c = 3.1272A^o which are in good agreement with the JCPDS data (65-2824).

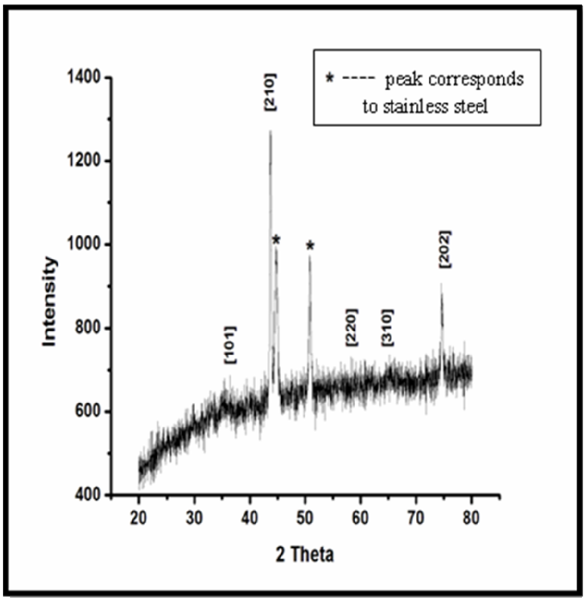

Figure 1. X-ray Diffractogram for RuO_2 thin films on stainless steel substrate.

Table 1: Comparison of observed 'd' values, obtained from XRD data with the standard'd' values, from JCPDS card No-65-2824

RuO_2 (films from this work)				RuO_2 (Card No. 65-2824)		
Peak No.	2 Theta	d	Intensity	d	Intensity	Plane
1.	36.0323	2.5035	603	2.5654	715	[101]
2.	44.8134	2.02084	985	2.0214	16	[210]
3.	58.2545	1.5825	731	1.5980	117	[220]
4.	65.2598	1.4285	739	1.4293	96	[310]
5.	73.5845	1.2861	727	1.2827	50	[202]

2.2 Morphological Characterization:

The surface morphological study of the RuO_2 thin film has been carried out from SEM image. Figure 2. Shows that the substrate is well covered with RuO_2 material. The thin film had a dense layer covered by agglomeration of particles forming a porous structure. At (X 5,000) magnifications, grained particles of RuO_2 with tetragonal structure were well seen, whereas, at higher magnification (X 10,000) a porous structure of ruthenium oxide was observed.

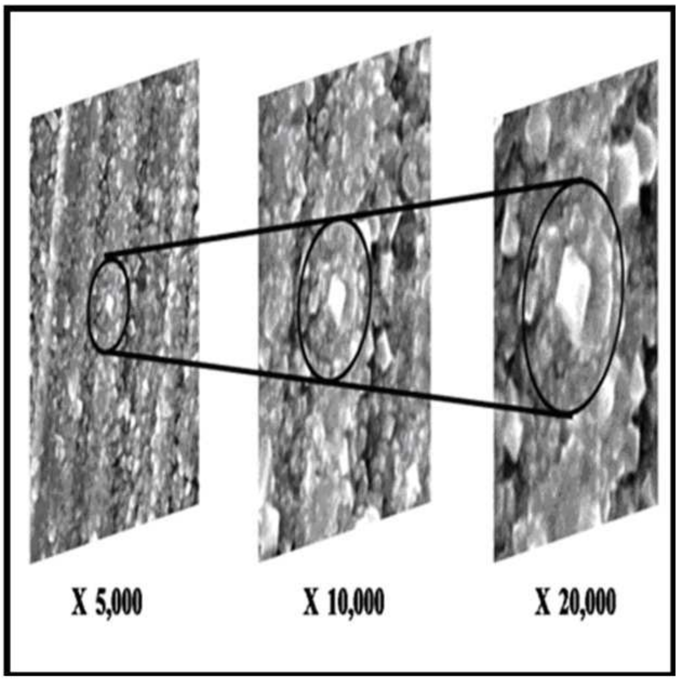

Figure 2. Surface morphologies of RuO_2 deposited at 900 °C on steel substrate at different resolutions.

3. Conclusions:

By this investigation, we had successfully developed the synthesis of RuO_2 thin films by sol gel spin coating deposition technique on stainless steel substrate .Through XRD examination it had been demonstrated the crystalline RuO_2 with tetragonal structure was obtained. The morphology showed that the substrate was well covered with RuO_2 material. The thin film had a dense layer covered by agglomeration of particles forming a porous structure.

Acknowledgement:

One of the author wish to acknowledge the U.G.C, New Delhi for financial support through the Major Research Project F No. 42-123/2013(SR).

4. References:

1. Gujar T.P., Kim W.Y., Puspitasari I., Jung K.D., Joo O.S, Electrochemically Deposited Nanograin Ruthenium Oxide as a Pseudocapacitive Electrode, Int. J. Electrochem. Sci., 2007, 2, 666.
2. Zheng J.P., Cygan P.J.,Jow T.R , Hydrous Ruthenium Oxide as an Electrode Material for Electrochemical Capacitors, J. Electrochem. Soc. 1995, 142, 2699.
3. Huang Y.S. and Liao P.C., Solar Energy Mater. Sol. Cells,1998, 55 , 179.
4. Zheng J.P, Cygan P.J., Jow T.R, Hydrous Ruthenium Oxide as an Electrode Material for Electrochemical Capacitors, J. Electrochem. Soc. 1995,142 ,2699.
5. Park B.O., Lokhande C.D., Park H.S., Jung K.D., Joo, O.S., Electrodeposited ruthenium oxide (RuO_2) films for electrochemical supercapacitors, Journal of materials science ,2004, 39 ,4313.
6. Khorasani-Motlagh M., Noroozifar M.,Yousefi M., A Simple New Method to Synthesize Nanocrystalline Ruthenium Dioxide in the Presence of Octanoic Acid As Organic Surfactant, Int. J. Nanosci. Nanotechnology.2011,7-4,167.

*****