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...ctural characterization of SnO_2 thick film doped with SiC

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...RACT A series of thick film samples with SnO_2 (active material), SiC (dopant) and ethyl ...ose and propylene glycol (organic binder) have been prepared using screen printing method. The ...ess of samples prepared is between 1.10±0.01 μm to 2.36±0.01 μm. X-ray analysis has been done ...ing Philips PW Diffractometer. The diffraction peak from the X-ray analysis shows the sample have ...degree of crystallinity. The lattice constant calculated for each sample shows that the samples ...uced has a tetragonal structure and the presence of SiC as dopant did not change the structure of ...O_2.

...O_2, Thick Film, Screen Printing, Structure, XRD)

INTRODUCTION

...thick films prepared using various methods ...been widely reported [1-4]. Method of ...ing SnO_2 thick film using screen printing ...is very rare [5-6]. In this research screen ...ing method had been chosen to produce ...thick film. This method had been used ...se of low cost, easiness and can be ...ated [7-8]. In this research the structural ...ies of SnO_2 thick film doped with SiC ...discussed.

MATERIALS AND METHOD

...printing technique has been used in this ...to produce SnO_2 thick film sample [9]. ...1 shows the percentage in weight percent ...composition used to produce the paste. 6 ...propylene glycol had been used as organic ...for each sample with the sintering ...ature of 600°C for 1 hour.

Table 1: Composition used to produce the screen printing paste.

Sample	Weight Percent (%)		
	SnO_2	Ethyl cellulose	SiC
S	50	50	0
S1	4.75	4.75	5
S2	45	45	10
S3	42.5	42.5	15
S4	40	40	20

To study the structural characteristic of each sample produced, X-ray diffraction was used. The sample with dimension of 1 cm x 1 cm was prepared on a glass substrate. The sample was then analysed using Philips PW 1390 Diffractometer. This instrument uses Cu Kα ray with the wavelength of 1.5405 Å. The X-ray diffraction data from the samples was then compared with JCPDS. From the X-ray diffraction graph produced, the lattice constant has been calculated using equation (1).

$$d_{hkl} = \sqrt{\frac{h^2 + k^2}{a^2} + \frac{l^2}{c^2}} \qquad (1)$$

RESULTS AND DISCUSSION

The diffraction pattern of each sample is shown in Figure 1. d_{hkl} value for all the samples was compared with standard data (JCPDS-ICDD, 1995) to identify the diffraction peak produced by SnO_2 or SiC. Table 2 and 3 show the d_{hkl} values for all the samples studied.

Diffraction peaks for S1 sample having 5 wt.% SiC shows high intensity for SnO_2 with the orientation of (110), (101) and (211). The SiC peaks are obvious but intensity comparison indicates comparatively smaller quantity to that of SnO_2. The lattice constant has been calculated using equation (1). The lattice constant for sample S1 is 4.7414 Å and c is 3.1852 Å.

X-ray diffraction spectrum for sample S2 consisting of 10 wt.% SiC shows changes compared to sample S1. There is an increase of intensity in the peak of SiC with the orientation of (011) with the intensity of 19.2% compared to S1 sample with the intensity of 5.4%. The number of diffraction peaks for SiC also increases compared to S1 sample. This shows that the presence of SiC is clearer with increase in dopant. Lattice constant for S2 sample has been calculated using equation (1). The calculated lattice constants a and c for S2 sample were a = 4.7344 Å and c = 3.1835 Å.

For S3 sample, consisting of 15 wt.% SiC, dominant diffraction peak for SiC occurs at the orientation of (1011), (0117), (0168), (1136), (2071) and (10127). This shows the increase of SiC peaks compared to S2 sample. Intensity for SiC peaks also increases. Diffraction peak for SnO_2 still shows the highest intensity with the orientation of (110), (101) and (211). This shows that the presence of SiC is much clearer with increase in weight percent of dopant. From the diffraction peak of SnO_2, the lattice constants were calculated. The value of lattice constant for S3 is a = 4.7511 Å and c = 3.1910 Å.

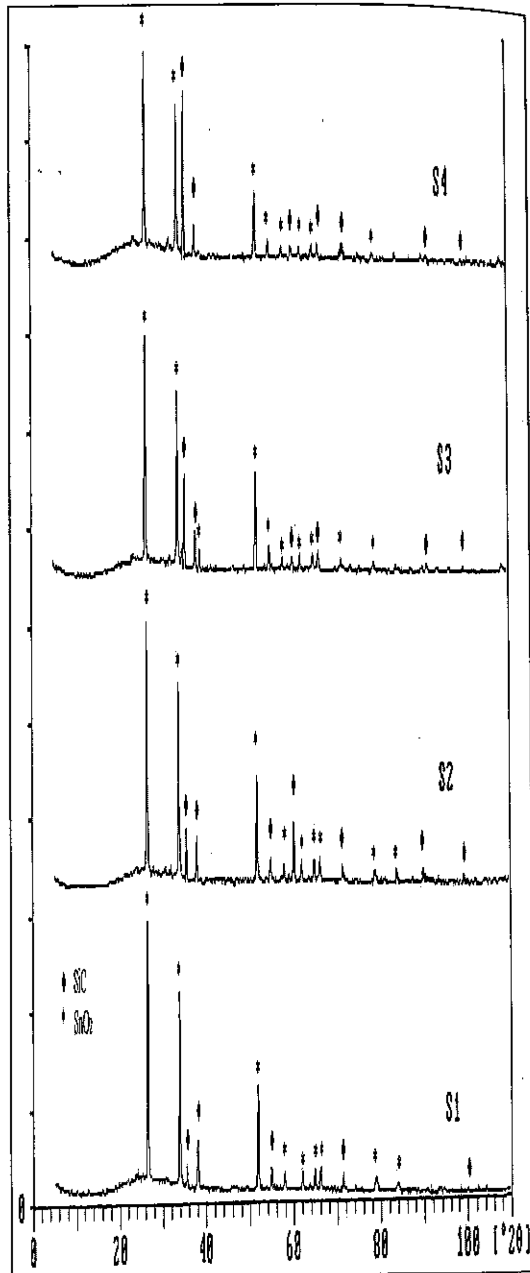

Figure 1. X-ray diffraction spectrum for SnO_2 thick film samples doped with different weight percent of SiC.

Table 2: d_{hkl} value for S1 and S2 samples with 5 wt.% and 10 wt.% of SiC.

Sample and SiC wt.%	d_{hkl} (Å)	I/Io (%)	Identity (hkl)
S1 5 wt.% SiC	3.3527	100	SnO_2 (110)
	2.6448	73.8	SnO_2 (101)
	2.5208	5.4	SiC (0117)
	2.3673	17.6	SnO_2 (111)
	1.7639	40.1	SnO_2 (211)
	1.674	8.6	SiC (0159)
	1.5930	5.6	SnO_2 (022)
	1.4978	6.2	SnO_2 (310)
	1.4423	7.6	SnO_2 (112)
	1.4148	7.6	SiC (1136)
	1.3212	3	SnO_2 (202)
	1.2147	4.1	SnO_2 (321)
	1.532	1.9	SnO_2 (222)
	0.9491	2.3	SiC (10127)
S2 10 wt.% SiC	3.3477	100	SnO_2 (110)
	2.6418	79.1	SnO_2 (101)
	2.5157	19.2	SiC (0117)
	2.3669	17.2	SiC (1025)
	1.7628	42	SnO_2 (211)
	1.6732	8.8	SnO_2 (220)
	1.5916	5.8	SnO_2 (002)
	1.5387	23.3	SiC (0168)
	1.4969	7.0	SnO_2 (310)
	1.4375	7.7	SnO_2 (112)
	1.4140	8.6	SnO_2 (301)
	1.3181	2.5	SnO_2 (320)
	1.2131	3.8	SnO_2 (321)
	1.538	3.6	SnO_2 (222)
	1.0798	2.6	SiC (2071)
	0.9490	2.6	SiC (10127)

Figure 1 shows that the diffraction for S4 sample with 20 wt.% of SiC. There is an increase of SiC peaks with an increasing intensity. SnO_2 diffraction peak still shows high intensity peak with the orientation of (110), (101) and (211). SiC diffraction peak is much more clear showing the presence of SiC in the sample. Lattice constant values for S4 sample were, a = 4.7431 and c = 3.1798 Å.

Table 3: D_{hkl} value for S3 and S4 samples with 15 wt.% and 20 wt.% of SiC.

Sample and SiC wt.%	d_{hkl} (Å)	I/Io (%)	Identity (hkl)
S3 15 wt.% SiC	2.6490	74.7	SnO_2 (110)
	2.5708	7.6	SiC (1011)
	2.5229	39.6	SiC (0117)
	2.3723	15.3	SnO_2 (111)
	1.7657	41.2	SnO_2 (211)
	1.6759	9.8	SnO_2 (220)
	1.5944	5.3	SnO_2 (022)
	1.5408	4.6	SiC (0168)
	1.4993	6.5	SnO_2 (310)
	1.4388	6.5	SnO_2 (112)
	1.4150	7.6	SiC (1136)
	1.3221	3.3	SnO_2 (202)
	1.2151	3.4	SnO_2 (321)
	1.0805	2.0	SiC (2071)
	0.9494	2.3	SiC (10127)
S4 20 wt.% SiC	2.6452	76.6	SnO_2 (110)
	2.5215	82.9	SiC (0117)
	2.3702	14.7	SiC (1025)
	1.7646	34.2	SnO_2 (211)
	1.6749	8.7	SnO_2 (220)
	1.5920	4.8	SnO_2 (002)
	1.5409	5.4	SiC (0168)
	1.4971	4.6	SnO_2 (310)
	1.4384	6.9	SnO_2 (112)
	1.4147	7.2	SiC (1136)
	1.3161	3.2	SiC (2017)
	1.2144	3.0	SnO_2 (321)
	1.0802	2.2	SiC (2071)
	0.9495	1.9	SiC (10127)

CONCLUSIONS

SnO_2 thick film doped with SiC and sintered at 600 °C for 1 hour had been analysed thrugh X-ray diffraction spectrum (XRD). The presence of diffraction peaks for each sample shows that it has high degree of crystallinity. The diffraction peak for SnO_2 on every sample isdominant and diffraction peak for SiC increases with increase of weight % of dopant used in each sample. The lattice values, a and c for each sample had been calculated. The value of a is in the range of 4.734 Å to 4.751 Å while the value of c is in the

range of 3.179 Å to 3.191 Å. The values obtained show that the structure of each sample produced is tetragonal and the structure of SnO_2 did not change with increase in dopant. The variation in the a and c values for SnO_2 dopant can be attributed to the strain in the crystal structure of the host material due to the presence of the dopant.

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