

PL and TL Study of Cu in SrO

D.R. Taikar^{1*}, C.P. Joshi², S.V. Moharil³

¹Department of applied physics, J.L. Chaturvedi College of Engineering, Nandanvan, Nagpur.

²Physics Department, Shri Ramdeobaba K. N. Engineering College, Katol Road, Nagpur.

³Department of Physics, Nagpur University, Nagpur, 440010, India

* Corresponding author: deepak_taikar@rediffmail.com, deepak_taikar@yahoo.co.in

Abstract

SrO doped with (0.01%) Cu phosphor was prepared by the co-precipitation method using $(\text{NH}_4)_2\text{CO}_3$ as a precipitating agent and annealed at 1000°C . The crystal structure of SrO similar to NaCl or rock salt type. X-ray diffraction pattern was recorded on Philips PANalytical X'pert Pro diffractometer. X-ray powder diffraction (XRD) analysis confirmed the formation of SrO:Cu. It matched with ICDD data file 74-1227. Photoluminescence and Thermoluminescence studies were carried out. PL measurements showed that the phosphor exhibited Broad blue emission band ranging from 395 to 525 nm, peaking around 460 nm and a shoulder around 420 nm which are assigned to the $3d^94s \rightarrow 3d^{10}$ transitions of Cu^+ ions. The excitation spectrum shows two excitation peaks around 230 nm and 270 nm. TL measurement shows that phosphor exhibit thermoluminescence property. TL glow curve peak obtained at 310°C .

Keywords: Co-precipitation, photoluminescence, thermoluminescence

1.0 INTRODUCTION

Cu is known to exhibit characteristic luminescence corresponding to $3d^94s \rightarrow 3d^{10}$ transitions. Schemes for using this emission for lasing have been proposed [1,2]. Proposals have also been made to use photostimulated luminescence of Cu for X-ray imaging [3–5]. Cu emission has also been used in thermoluminescence dosimetry phosphors such as $\text{LiF}:\text{Mg,Cu,P}$ [6], $\text{Li}_2\text{B}_4\text{O}_7:\text{Cu}$ [7,8]. Cu emission can also be used as blue component of full color electroluminescent display devices [9,10].

In this paper we report photoluminescent and thermoluminescent property of Cu doped SrO.

1.1 EXPERIMENTAL

SrO phosphors doped with Cu ion synthesized by co-precipitation method. Initially stoichiometric amounts of strontium nitrate and dopants (copper nitrate) were dissolved in dilute HNO_3 (s.d.fine chem. AR) separately. Then the solutions were mixed. Ammonium carbonate $(\text{NH}_4)_2\text{CO}_3$ solution was then added slowly to the mixture. Precipitate thus obtained in carbonate form was separated by filtering, dried and thoroughly crushed to yield fine powder. It was decomposed by heating in air at 1000°C for 1 hour to yield SrO:Cu(0.01%). X-ray diffraction patterns were recorded on Philips PANalytical X'pert Pro diffractometer.

Photoluminescence (PL) spectra in the spectral range 220-700 nm were recorded at room temperature on Hitachi F-4000 spectro-fluorimeter.

1.2 RESULTS AND DISCUSSIONS

Fig. 1 shows the crystal structure of SrO similar to NaCl or rock salt type. The space group of this structure is called Fm3m (in Hermann-Mauguin notation).

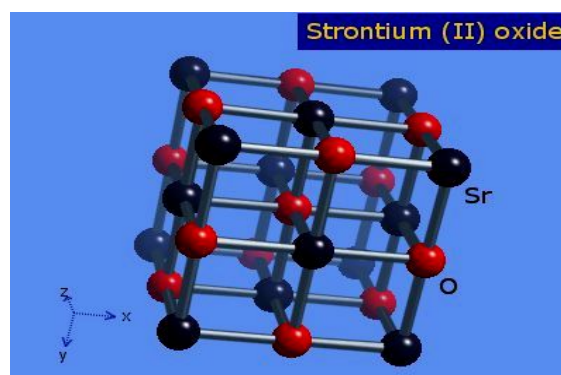


Fig. 1 Crystal Structure of SrO

Strontium oxide forms crystals with face-centered cubic symmetry with a two atom basis. The first atom is located at each lattice point, and the second atom is located half way between lattice points along the fcc

unit cell edge. The coordination number of each atom in this structure is 6: each cation (Sr^{2+}) is coordinated to 6 anions (O^{2-}) at the vertices of an octahedron, and similarly, each anion is coordinated to 6 cations at the vertices of an octahedron.

The stick patterns deduced from the diffraction data obtained for the SrO sample prepared by co-precipitation method as shown in fig.1. The patterns are compared with the major lines in the ICDD data file 74-1227. An excellent match is seen.

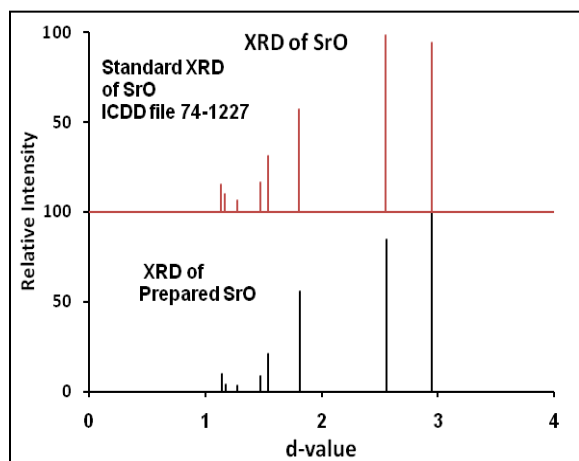


Fig.1 XRD of SrO

The UV absorption of Cu^+ may occur due to the interconfigurational transitions such as $3d^{10} \rightarrow 3d^9 4s$ and $3d^{10} \rightarrow 3d^9 4p$. The $3d^{10} \rightarrow 3d^9 4s$ transition is parity forbidden in the free ion but is partially allowed in a host material by coupling with lattice vibrations of odd parity. Such transitions in different alkali halide crystals have been extensively studied by McClure and co-workers [11-13]. The ligand field interactions [14] may split the excited $3d^9 s$ state into $^1T_{2g}$, $^3T_{2g}$, 1E_g and 3E_g components. The triplets may be split further by spin-orbit interactions [15,16]. However, only transitions to 1E_g and $^1T_{2g}$ state from ground $^1A_{1g}$ state are spin allowed.

Fig.2 shows the PL spectra of $\text{SrO}:\text{Cu}(0.01 \text{ mol}\%)$. Broad blue emission band (fig. 7.21, curve a) is observed ranging from 395 to 525 nm, peaking around 460 nm and a shoulder around 420 nm which are assigned to the $3d^9 4s \rightarrow 3d^{10}$ transition of Cu^+ ions. The excitation spectrum (fig. 7.21, curve b) shows two excitation peaks around 230 nm and 270 nm attributed to transitions from ground state $^1A_{1g} \rightarrow ^1T_{2g}$ and $^1A_{1g} \rightarrow ^1E_g$ respectively.

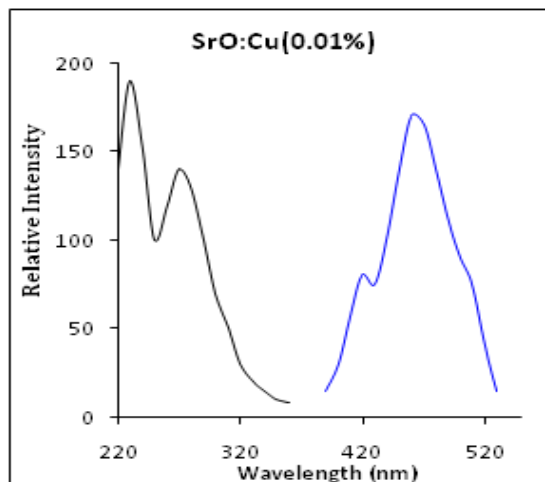


Fig.2 PL spectra of SrO:Cu

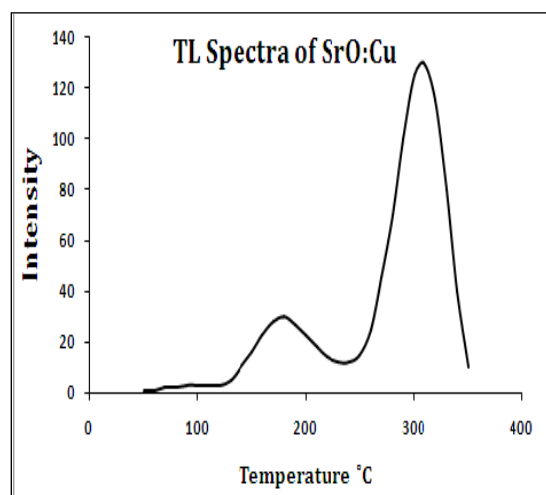


Fig.3 TL spectra of SrO:Cu

Fig.3 Show TL spectra of $\text{SrO}:\text{Cu}$. The TL spectra show two peak one at 180 °C and 310 °C, when phosphor exposed to γ -rays from ^{60}Co source for 100 Rad. The phosphor was irradiated at RST cancer Hospital, Nagpur.

2.0 CONCLUSION

$\text{SrO}:\text{Cu}^+$ phosphor successfully prepared by co-precipitation method using $(\text{NH}_4)_2\text{CO}_3$ followed by annealing at 1000°C. Photoluminescence measurements indicate that the phosphor exhibit efficient emission under UV excitation. TL measurement shows that phosphor exhibit thermoluminescence property. TL glow curve peak obtained at 310°C.



ACKNOWLEDGEMENT

DRT is thankful to Principal, Shri Ramdeobaba K.N. Engineering College, for granting permission to carry out the work. DRT is also thankful RST cancer Hospital, Nagpur for providing facility of source of γ -rays irradiation.

References:

1. G. Boulon, in: Spectroscopy of Solid State Laser Type Materials, Ed. B Di Bartolo, Plenum Press, New York 1987 (pp. 223–266).
2. G. Le Flem, J. Alloys Compd. 188, 36 (1992).
3. H. Nanto, T. Usuda, H. Sokooshi, S. Nakamura, K. Inabe, and N. Takeuchi, Sens. Actuators B10, 197 (1993).
4. P. K. Bandopadhyaya, G. W. Russel, and K. Chakraborti, Radiat. Meas. 30, 51 (1999).
5. Y. Masumoto and S. Ogaswara, Jpn. J. Appl. Phys. Lett. 38, L623 (1999).
6. T. K. Gundurao, J. R. Sarwade, and S. V. Moharil, Radiat. Eff. Defects Solids 138, 177 (1996).
7. D. I. Shahare, B. T. Deshmukh, S. V. Moharil, S. M. Dhopte, P. L. Muthal, and V. K. Kondawar, phys. stat. sol. (a) 141, 329 (1994).
8. M. Martini, C. Furetta, C. Sanipoli, A. Scacco, and T. K. Sommaiah, Radiat. Eff. Defects Solids 135, 133 (1995).
9. W. Park, T. C. Jones, and C. J. Summers, Appl. Phys. Lett. 74, 1785 (1999).
10. K. Ohmi, K. Yamabe, H. Fukuda, T. Fujiwara, S. Tanaka, and H. Kobayashi, Appl. Phys. Lett. 73, 1889 (1998).
11. J. Simonetti and D.S. McClure, Phys. Rev. 16 (1977) 3887.
12. S.A. Payne, A.B. Goldberg and D.S. McClure, J. Chem. Phys. 78 (1983) 3688.
13. S.A. Payne, R.H. Austin and D.S. McClure, Phys. Rev. B 29 (1984) 32.
14. H. Chermetti and C. Pedrini, J. Chem. Phys. 75 (1981) 1869.
15. A.B. Goldberg, D.S. McClure and C. Pedrini, Chem. Phys. Lett. 87 (1982) 508.
16. J.M. Berg, R.L. Chien and D.S. McClure, J. Chem. Phys. 87 (1987) 7.