Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Archives of Physics Research, 2011, 2 (2): 50-54
(http://scholarsresearchlibrary.com/archive.html)

Scholars Research Library
ISSN 0976-0970
CODEN (USA): APRRC7

Studies on growth parameters of Lead Iodide crystals by Surface topography grown gel technique

D. S. Bhavsar

P.G. and Research Department of Physics, Pratap College, Amalner 425 401 India

---

ABSTRACT

The Lead Iodide crystals have been grown by gel technique at constant temperature of 30^{0}C. Then, these crystals were characterized by XRD, Surface topography, and EDAX. XRD of these crystals, were recorded and compared. They are almost matching with ASTM data of Lead Iodide (Card No.7/235). Lattice constants are observed to be sensitively affected by doping. The structure of the Lead Iodide found to be polycrystalline having hexagonal structure. The surface topography of these thin films has been related to the growth parameters. It is established that the growth has been taken placed by two-dimensional nucleation mechanism and by spreading and pilling of growth layers. The elemental analysis of these crystals infers the proper inclusion of Lead and Iodine.

Keywords: Gel technique, Lead Iodide, Surface topography, EDAX

INTRODUCTION

Lead Iodide is a toxic, yellowish solid. It displays a range of colors with varying temperatures from bright yellow at room temperature to brick red. On cooling, its color returns to yellow. In its crystalline form it is used as a detector material for high energy photons including X-ray and **γ**- rays [1]. Lead Iodide is a direct semiconductor and crystallizes in hexagonal Cadmium Iodide like structures; atoms are located in layers of Pb and I perpendicular to c-axis, good surface parallel to the c-axis have not been obtained. The sequence of layers is repeated in the units of I-Pb-I held together by van der Wall's forces. Lead Iodide, with a band gap of 2.55 eV, is a technically class of materials in a view of its band to band type transition and high absorbance without any phonon-assisted mechanism, which makes it very useful in several electronic and optoelectronics device applications [2]. Lead Iodide has been studied as a very promising material with large applicability at room temperature nuclear radiation detectors [3-5].

In the present course of investigation, we have synthesized the Lead Iodide crystals by gel method. We further tried to correlate the growth relation of thin films, with the help of Surface topography. Moreover, the proper inclusions of Lead and Iodine were found.

MATERIALS AND METHODS

Analar Grade chemicals were used in the present work. The Lead Iodide crystals, Cu-doped and undoped, were grown by the gel technique. Good crystals have been obtained in a variety of ways by varying the parameters. In the present course of work, a solution of Sodium Silicate (sp.gr.1.04 g cm^{-3}) is mixed with Acetic Acid (1N), Lead Acetate (0.5N) and Copper Acetate (various concentrations from 0.1 to 0.5 N) and allowed to set the gel in constant temperature bath (30^0C). Then, after setting the gel, Potassium Iodide poured over the set gel slowly to get the crystals of undoped and copper-doped crystals.

The X-ray diffraction of these thin films, gel grown copper doped and undoped Lead Iodide crystals, has been carried with a 2θ range from 20^o to 90^0 by X-ray diffractometer (Philips PW-1730) using CuKα radiation with Ni filter (1.5418Å). Surface Topography of PbI_2 crystals was studied by Optical Microscope (Carl-Zeiss Epignost 2HD model). The scanning electron micrographs (SEM) of these films were obtained by Philips PW XL-30 and EDAX have been performed by Philips XL-30.

RESULTS AND DISCUSSION

XRDs of Lead Iodide crystals shown in figure 1. The lattice parameters ‘a’ and ‘c’ for Lead Iodide crystals have been computed from the observed‘d’ values by the method of successive refinement. Mean values of lattice parameters are given in table 1. XRD confirms the crystallinity and hexagonal structure of the grown crystals. Similar results were obtained for gel grown Zn-doped Lead Iodide thin films [6, 7].

Fig.2 shows an attachment of pentagonal and hexagonal platelet. The boundaries of the pentagonal and hexagonal crystals are well resolved. In the present course of investigation all the possible structures of the growth layers are seen. Most common features of the Lead Iodide crystals are seen throughout the investigation.

Fig.3 illustrates the triangular etch pits. From this figure it is established that the decay to the crystals has started. These may be due to keeping the crystals in the etching solutions for the long period.

Fig.4 depicts an attachment of the hexagonal structure. This is due to the fact that the fast reaction took place at the surface to the gel. Similar results were already reported [6, 7].

Fig.5 represents hexagonal growth layers with different arms. Such growth layers are observed only for those crystals, which are grown slightly below into the interface of the gel. The growth of the crystals near the interface of the gel is rapid growth.

The percentage composition of Lead and Iodine confirmed by energy dispersive power by X-rays. Fig.6 represent the elemental analysis of Lead Iodide performed by EDAX, indicating the proper proportion Lead and Iodine, Similar results were reported [8].

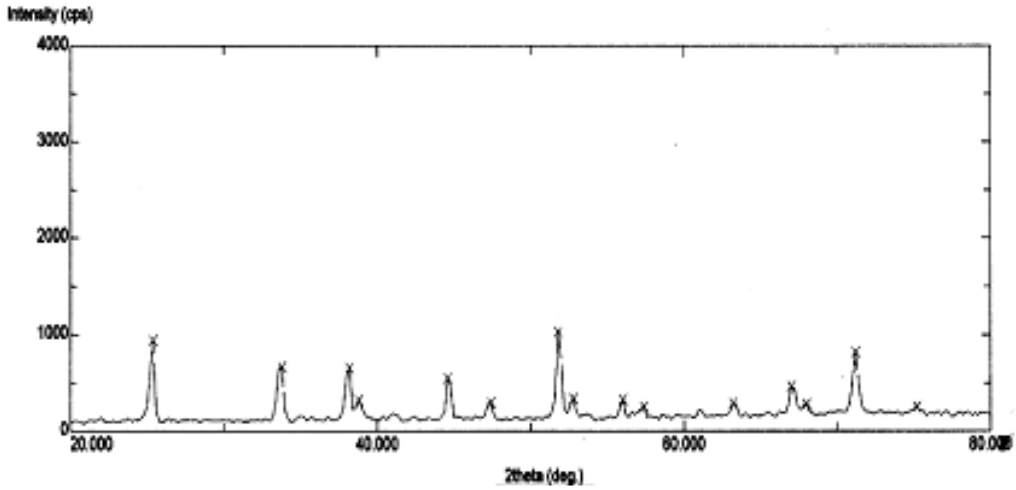

Fig.1 X-ray diffractogram of PbI_2 crystals

Table 1. Effect of preparative conditions lattice parameters

Compound	Dopant Concentration (In Molar)	Lattice Parameters a (Å)	c (Å)	c/a	V $(Å)^3$
Reported	-	4.575	6.989	1.5337	125.69
Undoped	-	4.575	7.0357	1.5479	128.85

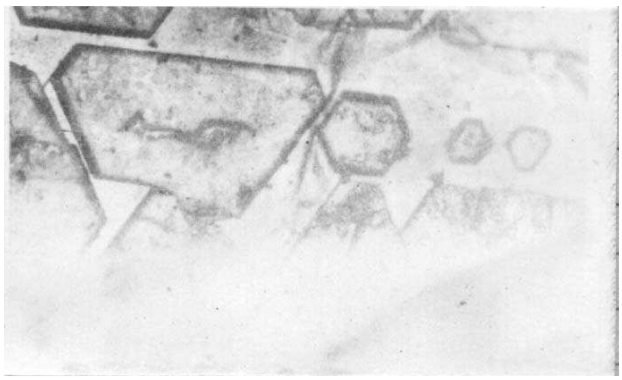

Fig. 2 Pentagonal and hexagonal structure

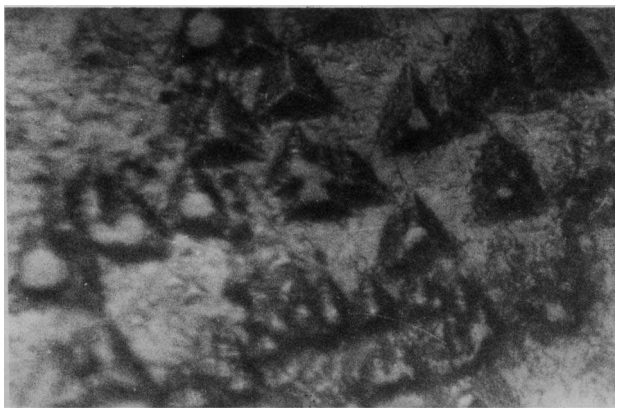

Fig. 3 Triangular etch pits

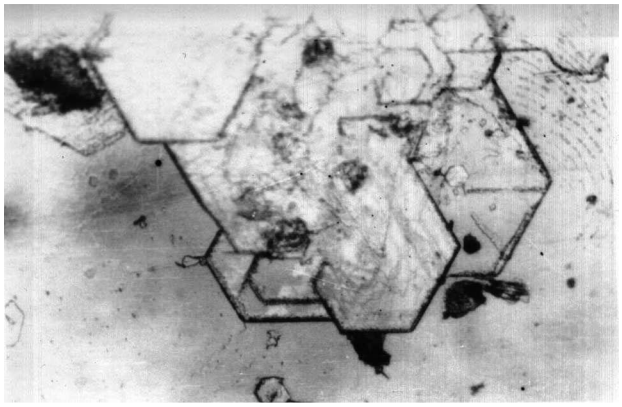

Fig. 4 Attachment of hexagonal structure

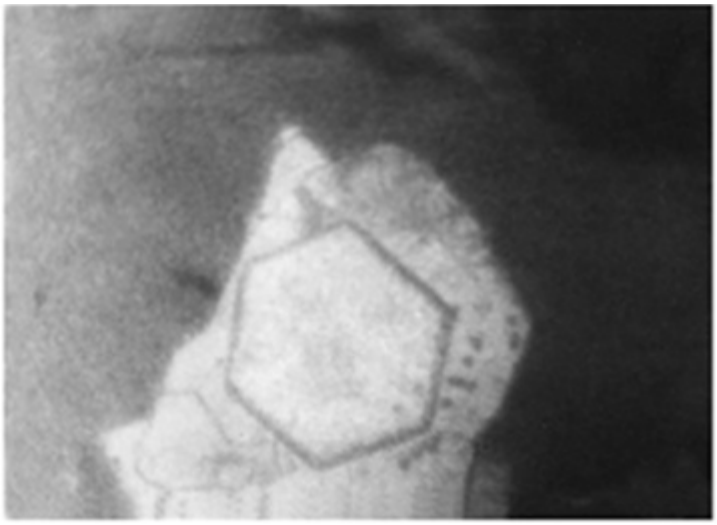

Fig. 5 Complete hexagonal structure

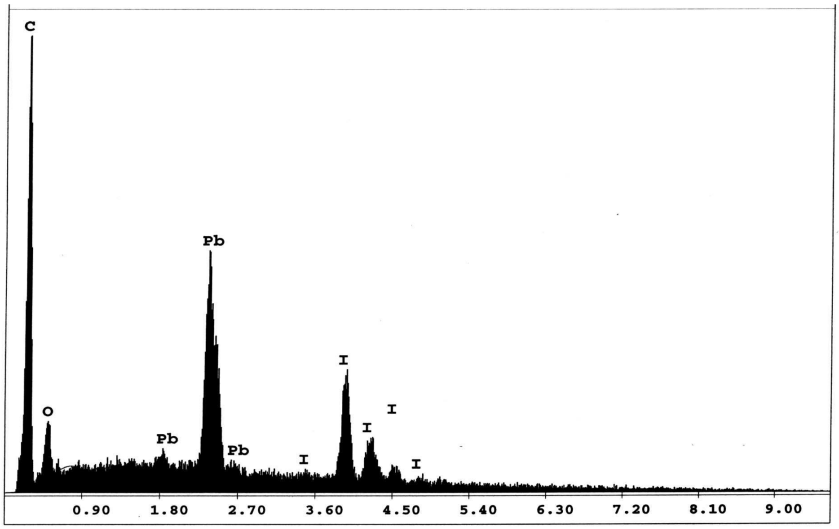

Fig.11. represents the EDAX of undoped Lead Iodide crystals.

CONCLUSION

1) Lead Iodide crystals successfully grown by gel technique.
2) The lattice parameters are well matching with the ASTM data of the Lead Iodide.
3) The structure of the crystals are hexagonal and polycrystalline in nature.
4) It is established that the growth has been taken placed by two-dimensional nucleation mechanism and by spreading and pilling of growth layers.

REFERENCES

[1] X.H.Zhu, Z.R.Wei and A.P.Xiang *Cryst.Res.Technol*. 42 (**2007**) 456-459.
[2] D.S.Bhavsar and K.B.Saraf J.Materials Sci., *Materials in Electornics* 14 (**2003**) 195-198
[3] M.A.George, M.Azoulay, H.N.Jauatrtha, Y.Biao, A.Burger, W.E.Collins and E.Silberman, *J.Cryst.Growth* 137 (**1994**) 299.
[4] J.C.Lund, K.S.Shah, M.R.Squillante, L.P.Moy, F.Sinclair and G.Entine, *Nucl. Instrum. Meth. Phys. Res. A* 283 (**1989**) 299
[5] T.Shoji, K.Ohba, T.Suchiro and Y.Hiratate, *IEEE Trans.Nucl.Sci* 42 (**1995**) 659.
[6] D.S.Bhavsar and K.B.Saraf, *Cryst.Res..Technol*. 37 (**2002**) 51-55.
[7] D.S.Bhavsar and K.B.Saraf, Materials, Chemistry and Physics, 78 (**2003**) 630-636.
[8] Kuiry S.C., Roy K.S. and Bose S.K. *Mate. Res. Bulletin* 31 (3) (**1996**) 317-327.