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Effect Of Antimony Doping On The Structural Properties Of Calcium Fluorid Powders

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Abstract – Sb doped calcium fluoride transparent conducting powder were prepared by solid state reaction method. Structural properties of the samples were investigated as a function of various Sb-doping levels (x=0.00-0.01-0.02-0.03). The results of x-ray diffraction have shown that the samples are polycrystalline structure in cubic phase and show presence (111)، (220)، (311)، (400) planes in pure CaF_2 sample and The preferred orientation is (220) for pure CaF_2 . and we have peaks correspond to (012), (104), (110), (015) (220), (024), (122) for Sb for all samples and The preferred orientation is (015) for Sb for all samples. The average of crystallite size is within the range [4.111-0.920 nm] for all samples. The relative intensities, distance between crystalline planes (d), crystallite size (D) and lattice parameters (a) were determined

Keywords – powder, Calcium fluoride, solid state reaction, Structural properties, rare-earth ions.

I. INTRODUCTION

Calcium fluoride (CaF_2) density is 3.18 (g/cm^3) melting at 1633 (K) and crystalize in cubic structure with lattice constants a = 5.432 Å.

CaF_2 is presently the fastest known scintillator. It has an emission component with subnanosecond decay time [1,2].

CaF_2 has several scintillation emission bands. The fast scintillation light is emitted in the UV bands centered at 220 and 200 nm.

The decay time of the fast component varies between 600 and 800 ps [3].

CaF_2 has attracted much attention because of its wide range of potential applications in optoelectronic and microelectronic devices [4,5,6,8].

CaF_2 compounds doped with rare-earth ions have been reported to display unique luminescence properties and can thus be used as scintillators [7,,9,10,11].

II. EXPERIMENTAL

CaF_2: Sb powders (x = 0.00, 0.01, 0.02, 0.03) were prepared by a solid state reaction method. were accurately weighed in required proportions and were mixed and ground thoroughly using an Agate mortar and pestle to convert to very fine powders.

The grinding of the mixtures was carried out for 3 hours for all the powder samples. The ground powder samples were firing at 700°C for 3 hours.

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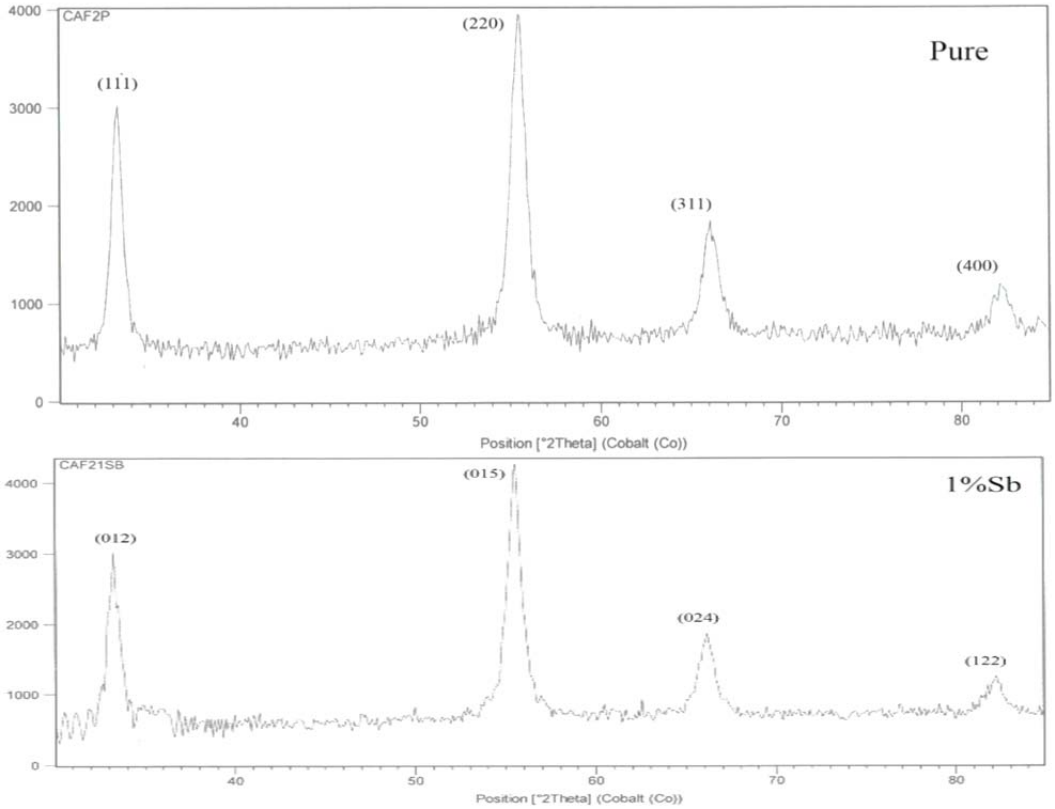
III. RESULTS AND DISCUSSIONS

3.1. Structural properties

The X-ray diffraction patterns of undoped and Sb doped CaF_2 powders prepared with various Sb concentration 0 wt%, 1 wt%, 2 wt% and 3 wt% are shown in Fig.1.

The XRD reveals that all samples are having polycrystalline nature with cubic structure.



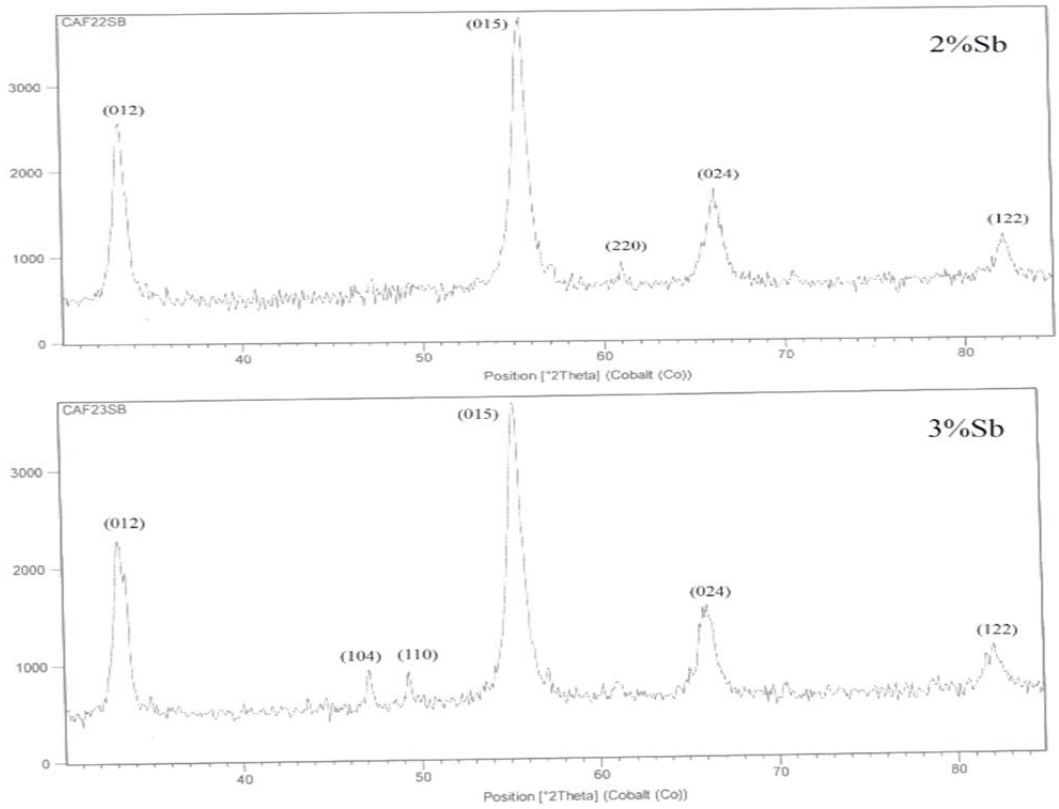


Fig.1: XRD results of pure CaF_2, 1 wt% Sb doped CaF_2, 2 wt% Sb doped CaF_2, 3 wt% Sb doped CaF_2

Table (1) shows results of structural values of undoped CaF_2 sample.

Samples S	2θ (deg)	)hkl(	d (A°)	Rel. int. [%]	β (deg)	D (nm)	Average D(nm)	Δ 10^{15}line/m^2	Lattice const. a(Å)
CaF_2 Pure	33.12	(111)	3.138	80	1.250	1.403	1.504	508.024	5.456
	55.23	(220)	1.929	100	1.720	1.103		821.956	
	65.78	(311)	1.647	48	1.350	1.483		454.692	
	82.23	(400)	1.360	33	1.100	2.029		242.904	

Table (2) shows results of structural values of Sb doped CaF_2 samples (x=0.01).

Samples	2θ (deg)	)hkl(	d (A°)	Rel. int. [%]	β (deg)	D (nm)	Average D(nm)	Δ 10^{15}line/m^2	Lattice const. a(Å)
CaF_2:Sb (1 wt%)	32.87	(012)	3.166	71	1.155	1.517	1.510	434.539	9.902
	54.86	(015)	1.942	100	1.750	1.082		854.172	
	66.01	(024)	1.648	42	1.520	1.319		574.791	
	82.02	(122)	1.363	31	1.050	2.123		221.870	

Table (3) shows results of structural values of Sb doped CaF_2 samples (x=0.02).

Samples	2θ (deg)	)hkl(	d (A°)	Rel. int. [%]	β (deg)	D (nm)	Average D(nm)	Δ 10^{15}line/m^2	Lattice const. a(Å)
CaF_2:Sb (2 wt%)	32.23	(012)	3.223	68	1.320	1.326	1.788	568.738	9.881
	55.03	(015)	1.938	100	1.920	0.987		1026.515	
	60.88	(220)	1.766	23	2.120	0.920		1181.474	
	65.92	(024)	1.644	47	0.560	3.578		78.112	
	81.98	(122)	1.364	32	1.050	2.121		222.289	

Table (4) shows results of structural values of Sb doped CaF_2 samples (x=0.03).

Samples	2θ (deg)	)hkl(	d (A°)	Rel. int. [%]	β (deg)	D (nm)	Average D(nm)	Δ 10^{15}line/m^2	Lattice const. a(Å)
CaF_2:Sb (3 wt%)	33.03	(012)	3.149	62	1.360	1.209	2.182	600.925	9.846
	47.11	(104)	2.239	25	0.620	2.960		114.134	
	49.08	(110)	2.155	24	0.450	4.111		59.170	
	55.18	(015)	1.931	100	1.720	1.103		821.956	
	65.98	(024)	1.644	43	1.150	1.744		328.781	
	82.01	(122)	1.363	31	1.180	2.889		280.243	

The relative intensities of undoped and Sb doped CaF_2 powders are calculated. The distance between crystalline planes values (d) are calculated by using following relation:

$$2d.\sin\theta = n\lambda \qquad (1)$$

Where d is distance between crystalline planes (A°), θ is the Bragg angle, λ is the wavelength of X-rays (λ=1.78897 A°).

The crystallite size is calculated from Scherrer's equation [12]:

$$D = \frac{0.94\lambda}{\beta cos\theta} \qquad (2)$$

Where, D is the crystallite size, λ is the wavelength of X-ray, ß is full width at half maximum (FWHM) intensity in radians and θ is Braggs's angle.

The dislocation density is defined as the length of dislocation lines per unit volume and calculated by following equation [13]:

$$\boldsymbol{\delta} = \frac{1}{D^2} \qquad (3)$$

The lattice constants a for cubic phase structure is determined by the relation [14]:

$$a = d\sqrt{h^2 + k^2 + l^2} \qquad (4)$$

Where d and (hkl) are distance between crystalline planes and Miller indices, respectively.

IV. Conclusion

This paper presents a study of structural properties of Sb doped CaF_2 powders prepared by solid state reaction method. X-ray diffraction patterns confirm that the samples have polycrystalline nature with cubic structure and show presence (111), (220), (311), (400) planes in pure CaF_2 sample.The preferred orientation is (220) for pure CaF_2 .

For 1%Sb we have peaks correspond to (012), (015), (024), (122). The preferred orientation is (015).

For 2%Sb We noticed appearance of this orientation (220).

For 3%Sb We noticed appearance of these orientations (104), (110).

The average of crystallite size is within the range [4.111-0.920 nm] for all samples. It was defined that the lattice constants a for all the samples, were almost identical with JCPDS values.

REFERENCE:

[1] Czaja. M, Gajowska S. B. The luminescence properties of rare-earth ions in natural fluorite. Phys Chem Minerals. 2012; 39: 639–648.

[2] Battikh. A. A, et al, "Studying of the Europium ion Effect on the Luminescence Calcium Fluoride Crystal. Tishreen University Journal. 2014; 36.

[3] Nanto. H, Nakagawa. R. Optically stimulated luminescence in Tm-doped calcium fluoride phosphor crystal for application to a novel passive type Dosimeter. Sensors and Materials. 2015; 27: 277–282.

[4] Available: www.optik-photonik.de. Calcium fluoride and barium fluoride crystals in optics. 2014.

[5] Elbatal. F. H. A, Marzouk. M. A, et al. Optical and FT Infrared Absorption Spectra of 3d Transition Metal Ions Doped in NaF-CaF2-B2O3 Glass and Effects of Gamma Irradiation.. Available: http:/dx.doi.org/. 2014.

[6] Zheng. W, Zhou, S. Sub-10 nm Lanthanide Doped CaF2 Nanoprobes for Time Resolved Luminescent Biodetection. Available: www.angewandte.org. 2013.

[7] Ravangave. L. S. Effect of doping concentration of Eu^{3+} ion on CaF2 nanoparticles. Digest Journal of Nanomaterials and Biostructures. 2010; 7: 575-578.

[8] Kishi, Y, Tanabe. S, et al. Fabrication and Efficient Infrared to Visible Upconversion in Transparent Glass Ceramics of Er Yb Co Doped CaF2 Nano Crystal. Journal of the American Ceramic Society. 2005; 88.

[9] Wanga. F, Fana. X, et al. Synthesis and luminescence behavior of Eu^{3+} doped CaF2 nanoparticles. Solid State Communications. 2005; 133: 775–779.

[10] Hraiech. S, Jouini. A. Breakage of Yb^{3+} pairs by Na^{+} in Yb^{3+} doped CaF2

[11] laser host. Ann. Phys. 2007; 32: 59–61.

[12] Antonyak. O. T, Vistovskyy. V. V. Defect Luminescence in CaF2 nanoparticles. Journal of luminescence. 2015; 167: 249–253.

[13] Mariappan. R., Ponnuswamy. V, & Suresh. P. Effect Of Doping Concentration On The Structural And Optical Properties Of Pure And Tin Doped Zinc Oxide Thin Films By Nebulizer Spray Pyrolysis (NSP) Technique. Superlattices and Microstructures. 2012; 52: 500-513.

[14] Turgut. G, Keskenler. E. F, Aydin. S, Sonmez. E, Dogan. S, Duzgun. B & Ertugrul. M. Effect Of Nb Doping On Structural, Electrical And Optical Properties Of Spray Deposited SnO2 Thin Films. Super lattices and Microstructures. 2013; 56: 107-116.

[15] Gurakar. S, Serin. T & Serin. N. Electrical And Microstructural Properties Of (Cu, Al, In)-Doped SnO2 Films Deposited By Spray Pyrolysis. *Advanced* Materials Letters. 2014; 5: 309-314.