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Synthesis and Characterization of Calcium doped Silver Chromite Spinel Nano-Particles and Ca. effect on its Band gap and Optical Properties.

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Abstract:
Silver chromites catalysts have newly been discussed by different preparation and utilization approaches. The results of all discussion explain that silver chromites is a proficient catalyst using for catalyses programmes at national and commercial level including worldwide environmental control of pollution. Various applications of calcium doped silver chromites in energy clean, laboratory. Eco-friendly approach naming sol-gel is used to get final sample and characterized by SEM, XRD, EDS and photoluminescence. Final sample approach is affected by various parameters. Furnance was used to sinter at 750-900oC for 4 hours intended ~1.56 eV band gap value, 28.881 nm crystalline size for doped sample and EDS describes calcium was successfully doped in silver chromite and emerged completely.

Keywords: Spinel, Chromate, Sol-Gel

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1. Introduction:

Clean and sustainable alternative energy sources are urgently needed because fossil fuel stocks are depleted daily. Due to its high energy density and eco-friendly qualities, hydrogen energy is a desirable replacement for fossil fuels. Low-dimensional nanostructure preparation has received a lot of attention recently due to its potential uses in a variety of fields. It was discovered that silver chromate is a good visible-light sensitive photocatalyst among these nanostructured materials. For lithium cells, silver chromate can be utilized as cathode.

Spinels usually have AB_2O_4 formula describes A, B metal ions categories Cr^{3+} red Fe^{2+} and also Zn^{2+} as blue with tetrahedral and octahedral locus respectively confirmed by Bragg and also

Nishikawa[1-5]. Spinals little detail structure described in 1915. Spinels form a massive family with interest as magnetic goods, sensor goods, ceramics, catalytic agency, ignition catalyst and photocatalyst [6]. $AgCr_2O_4$ were used to create a novel solid electrolyte system that Uthanthiraraj and Premchand [7] then examined for its ion transport, electrical, and electrochemical properties. On the other hand, visible-light sensitive materials such multi-metal oxides containing Ag(I) for organic photooxidation under visible-light irradiation and Cr element for photocatalytic water splitting have drawn a lot of interest[8-9]. $AgCr_2O_4$ nanostructures have been created so far using a variety of techniques [10]. Using a template, Liu et al. created $AgCr_2O_4$ necklace architectures made of single crystalline nanorods [11]. In order to study the impact of temperature, flow rate of reagent addition, silver and chromate concentrations, and precipitation method on the size of silver chromite particles, Alamdari et al. synthesised $AgCr_2O_4$ nanoparticles [12]. Additionally, Liu et al. reported on the bioinspired synthesis of $AgCr_2O_4$ quasi-nanorods and nanowires using liquid emulsion membranes [13].Silver chromite exhibits small band gap 1.80 eV with rare electronic and crystal format [14]. So $AgCr_2O_4$ type nanocomposite photocatalyst have been concocted [15-22].Numerous approaches have been adapted to prepare spinal fine powder including solgel, coprecipitation, and solid state case, hydrothermal and altered pinching case [23-27]. Among all approaches more precise final spinal result obtained by sol-gel. It is very easy, cheap, and suitable to environment and fast approach requiring low heat and calcinations [28].

Fig.1 Overview of spinel [4]

2. Experimental section:

Synthesis of required calcium doped silver chromite sample

Sol gel approach was adapted to get silver-doped calcium chromite fine powders. Then entire whole solutions of (Chromium, Calcium, Silver) nitrates and proper amount of citric acid were added in distilled water. The substantial solution was stirred for about 35 minutes on hot plate, when reach homogeneous, to set pH value 7 add ammonia drop wise, and also temperature was set at 90 °C. After that, fine powder was 4 hours calcined at 750-900 ^{o}C.

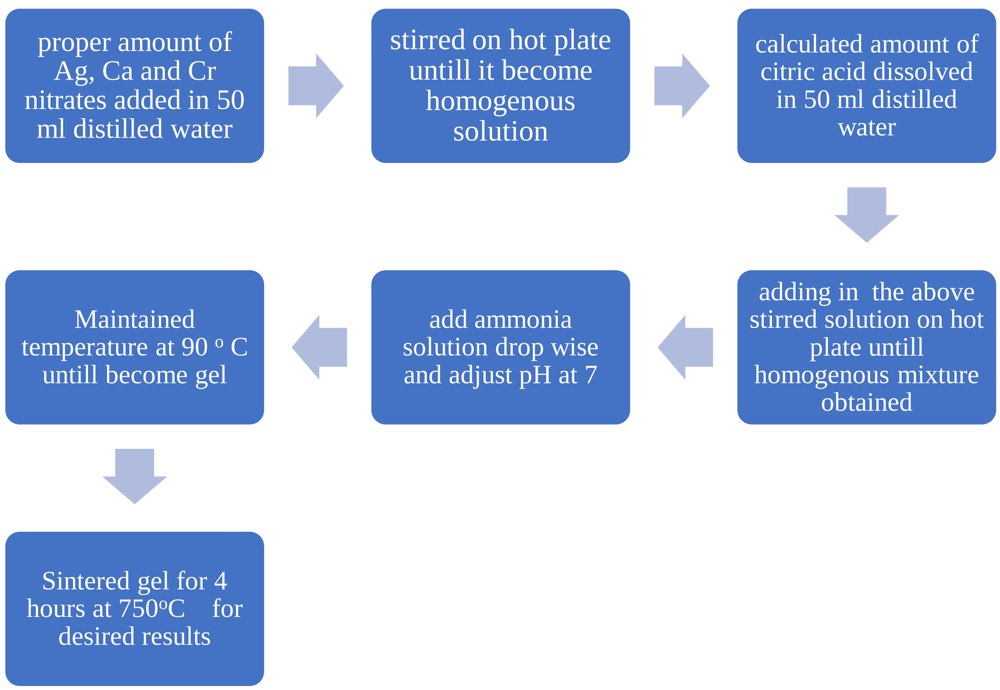

Fig. 2: schematic diagram of synthesis process ofcalcium doped silver chromites.

3. Results and discussions:

3.1. Instrumentation

The X-ray diffraction study was conducted using a Brucker D-8 X-ray diffractometer and a 40 VK X-ray source with a current of 40 mA and a step size of 0.02. For morphological and elemental studies, combined with photoluminescence spectroscopy at 325 nm with 40 MW of power, the 20 kV TESCAN VEGA 3 was used.

3.2. X-ray diffraction (XRD)

Crystal structure and also phase of sample is described by XRD. XRD graph describes 2θ values ranges 0-60 on X-axis showing prominent peaks at 24.5°, 28.88°, 38.28°, 44.53°, and 51.10° .Single phase of our sample silver chromate is obtained at 750℃ temperature. Crystal structure of our final as-formed sample is orthorhombic indicating no impurity presence.141/amd describes space group of silver chromates. At 750°C, we obtain the (214) phase of silver chromite with reference codes (JCPDS No. 26-0952). Ratio c/a is nearly 1.81.

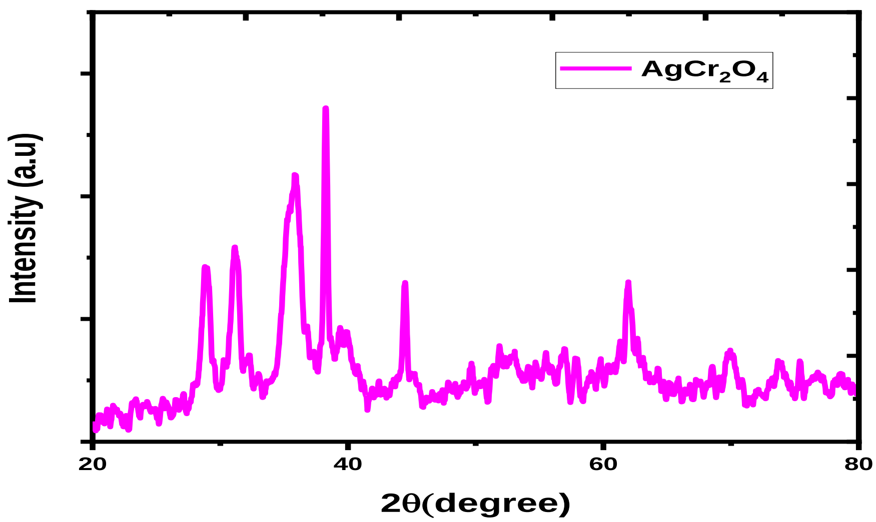

Fig. 3: XRD of pure silver chromite.

Table1:

2θ values (degree)	(hkl) value or miller indices	θ value (degree)	Intense peak FWHM or (β) values in radians	Crystalline size of nanoparticles (D)nm
28.791	100	14.3955	1.02664	28.881
31.142	110	15.571	1.38561	31.185
35.812	111	17.906	1.76041	35.697
38.259	111	19.1295	0.43908	38.260
44.470	200	22.235	0.36468	44.453

61.953	220	30.9765	0.64392	61.992
69.936	221	34.968	754.2482	74.003
				28.881nm

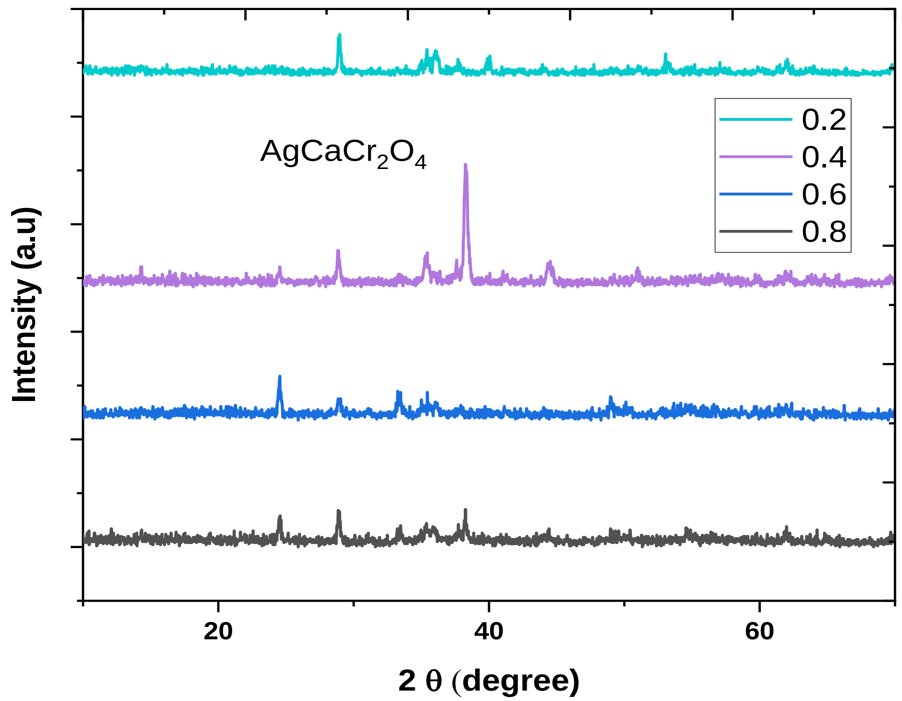

Fig. 4: XRD pattern of calcium doped silver chromites.

Size particle in average form is described by Bragg's equation. D =28.881nm describes size of crystalline interterpret by Scherer's equation D= Kλ/ βCos theta [29-33].

3.3. Photoluminescent spectra

In order to compute the band gap at a given energy state due to electron-hole recombination, the photoluminescence spectra were investigated .The PL spectra of calcium-doped $AgCr_2O_4$ describes wavelength in nm, and also intensity in a.u. The spectras are shown in fig. Peaks at 381nm, 372nm, 520nm and 539nm can be seen in each spectrum [34].$E_g = \frac{1240}{\lambda}$ by using this formula band gap intended ~1.56 eV.

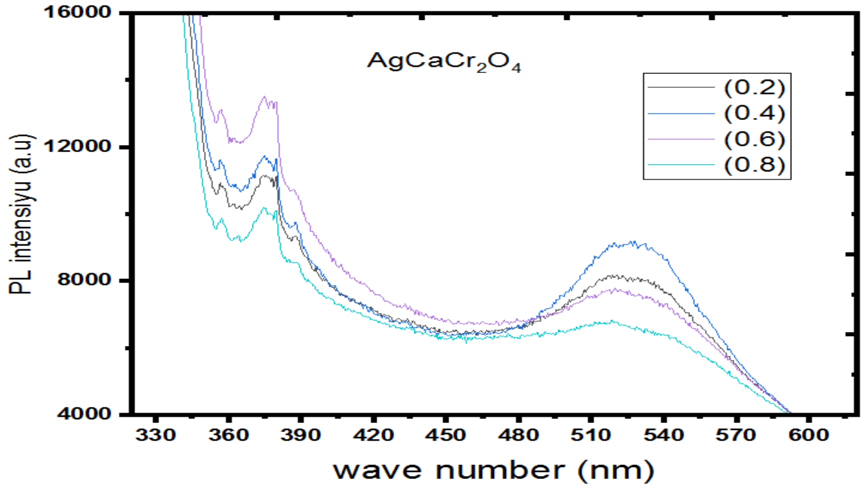

Fig. 5: PL spectra of calcium doped silver chromite.

3.4. Elemental analysis (EDS)

An analytical approach to measure elemental graphical and chemical characterization of final prepared sample called EDS. A unique set of prominent peaks and also X-Ray spectrum of each element is the basic principle of EDS [35]. EDS shows actual elements and also foreign impurities in my pattern of study [36].

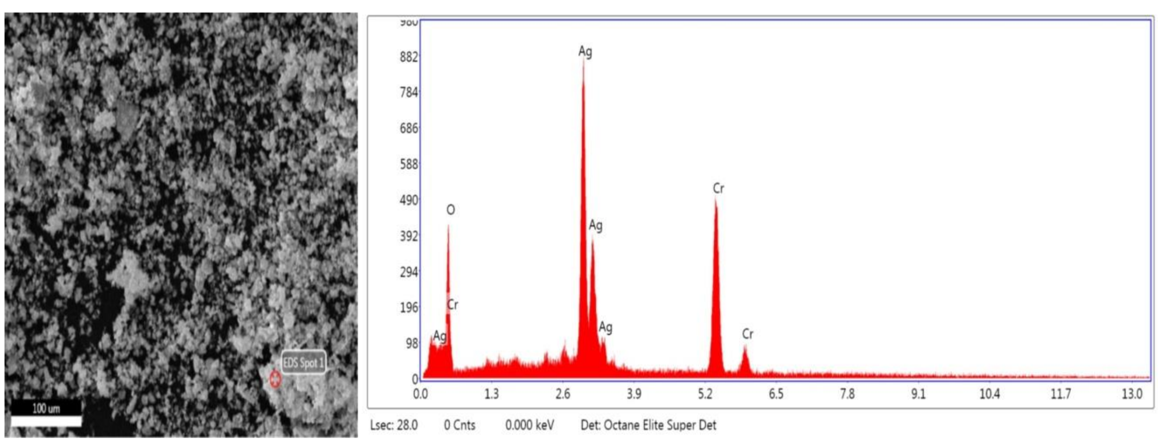

Fig. 6: EDS spot and analysis of $AgCr_2O_4$

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Table 2.

Sr.No.	Element	Weight %	Atomic %
1	O K	17.49	49.02
2	AgL	45.18	18.78
3	CrK	37.34	32.20

3.5. Morphological analysis (SEM):

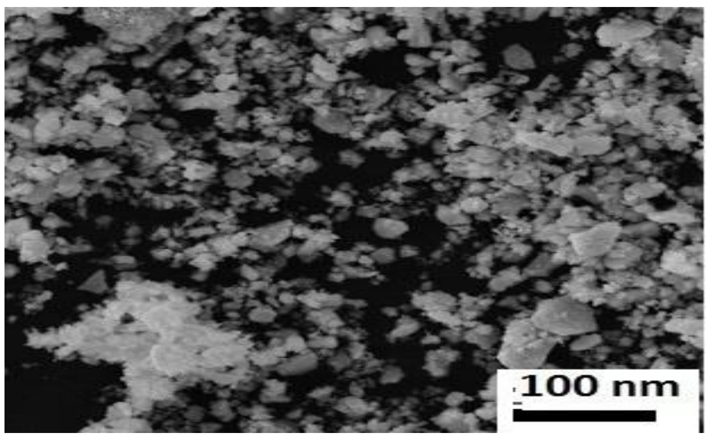
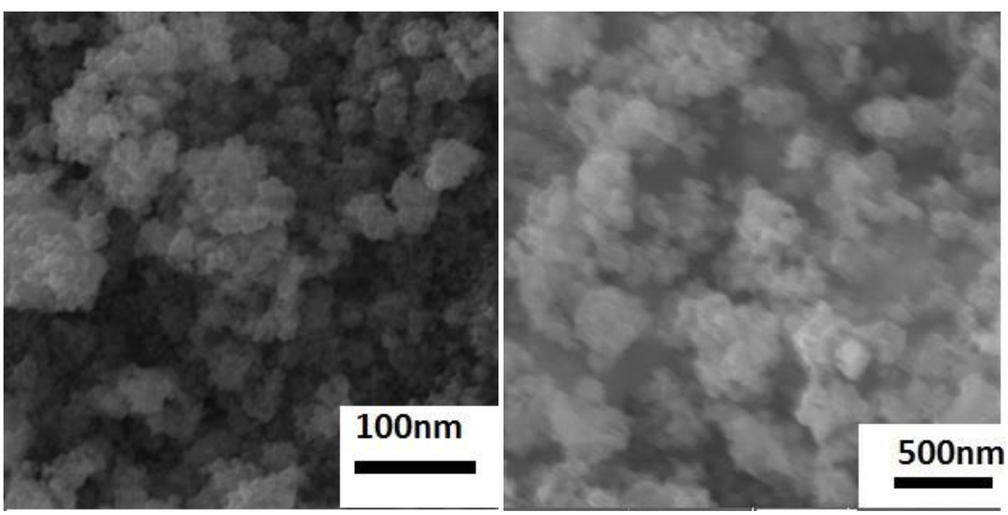
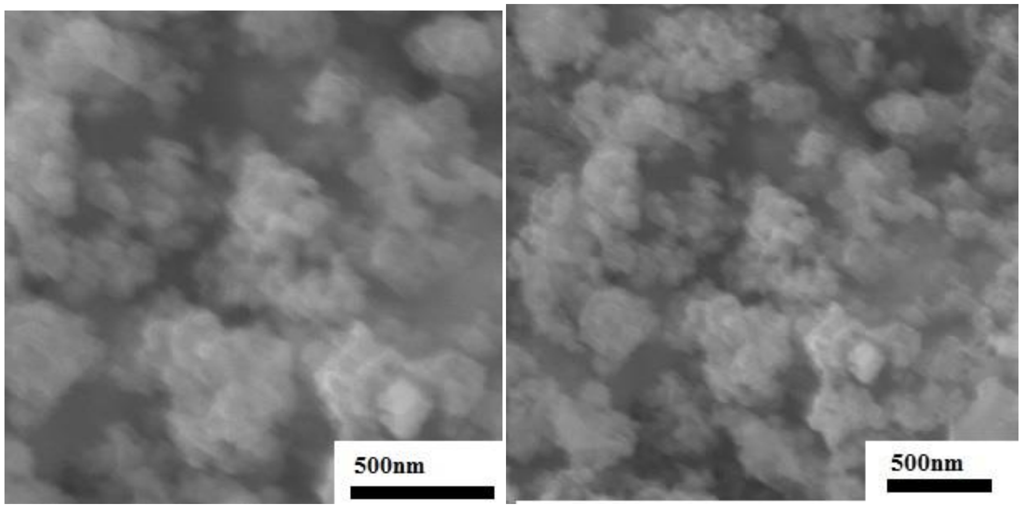


Fig. 7: SEM of $AgCr_2O_4$



0.2 **0.4**



0.6 **0.8**

Fig.7: SEM results showing doping of calcium in silver chromite with different concentration.

Fig7. describes silver doped spinel structure containing agglomeration of particles with average size of grain 20 nm-50nm consistent with XRD results. Results indicate nonuniform particles in all aspects and boundries of grains are visible [37].

Conclusion:

Sol-gel approach is used to get final product of silver doped calcium chromate with different concentration of silver (0.2, 0.4, 0.6, 0.8) sintered in furnace at 750-900^{o}C and characterized by EDS, SEM, Photoluminescence and XRD. During the preparation process calcium, silver and chromium nitrates are metal's precursors. The final product may use in laboratory and for optical, magnetic and electronic devices.

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