Preparation And Characterization of Agno3_Srcl2 Nanoparticles Doped with Silicon Mono Oxide on The Performance of Inorganic Photovoltaic Cells

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***Abstract*—Inorganic Photovoltaic cells (PCs) have been converted into a Investigate hotspot for the reason that brilliant light renovation efficiency, in this work, SrCl2 and AgNO3 doped with superior quality Silicon mono oxide (SiO) were construct effectively by the customized sol-gel method. During this work we investigated the optical combination, crystallographic structure, exterior morphology and simple composition of undoped and doped SiO nanoparticles with via FTIR, XRD, FE-SEM and Ed's analysis for its photovoltaic property. In all XRD results, the sharp peak centered on 26.70° can be certified to silicon mono oxide (002). The FTIR absorption band at 783.56 cm-1 and 1033.71cm-1 is characteristic of β phase. EDs shows trace elements are probable present in the samples. The purpose of this work is to put on more imminent among the optical properties of pure SiO and doped AgNO3_SrCl2 nanoparticles and their influence on the concert of photovoltaic cells.**

***Index Terms*—silicon mono oxide, silver nitrate and strontium chloride nanoparticles, solar cell applications, sol-gel methods**

I. INTRODUCTIONS

Substantial work is presently paying attention on the largest part generally study and used silicon mono oxide SiO, which is the most capable nanocomposites appropriate to its enhanced photovoltaic applications [1]. Silicon Mono Oxide is a non toxic, chemically, thermally and photo stable material which have a transcendent electronic, optic and catalytic properties [2]. Si is the next superlative rich substance on earth after oxygen. This is extensively use in the semiconductor industries [3]. Many scientists have reported that crystalline silicon solar cells in cycle pattern have shown terrible performance for cost-effective solar cell to electricity conversion. Polycrystalline silicon processing has established the probable to obtain the imaginary S-Q boundary of single- connection silicon photovoltaic cells with an extra average cost [4]. They said that the largest part usually used base material for production photovoltaic cell is boron doped p-type Silicon. N-type Si material as well second-hand for manufacture elevated competence photovoltaic cell but contain extra scientific challenge similar to obtain consistent doped the length of the brick compare to p-type material [5]. There are outcome in superior photovoltaic cell concert appropriate to the small imperfection concentration and the fine texture exterior of near to the ground reflector. The square cast mc silicon is additional low-cost and consequently extra cost-effective for photovoltaic modules [6][7]. Nanocrystalline SiO has revealed brilliant performance by assessment to other semiconductors such asTiO_2, ZnO, SnO_2, Nb_2O_5. In this paper $SrCl_2$ and $AgNO_3$nanoparticles doped silicon mono oxide. Silver and strontium nanoparticles may be applied the same as daylight diffusion fundamentals for increase photovoltaic cell power adaptation efficiency. The purpose of this labor is in the direction of put on extra imminent among the visual property of Ag and $SrCl_2$ nanoparticles and their influence on the concert of photovoltaic cells [8]. Ag nanoparticles surrounded in a Insulator substance include well-built diffusion property in radiance enlightenment, attributable to confined to a small area exterior Plasmon's. This consequence is a prospective way to accomplish illumination halter in silicon solar cells [9]. Doped

$SrCl_2$ nanocomposite is a promising atmosphere responsive understudy which is non-toxic, profuse give equivalent competence to solar cell [10]. Strontium is stimulating to researchers due to these captivating belongings of dopants on the photo radiant Property of the silicon chip. Strontium chloride because it is semiconductor quantum dots, high yield of luminescence properties they absorb light during the day and release it slowly for hours after wards. It is also known as high-energy beta emitters; generate electricity for space vehicles, remote weather stations [11], [12]. Production of nanoparticles to include a enhanced organize more particles dimension allocation, morphology, clarity, amount and excellence, by employ surroundings sociable reasonable process have for all time be a face up to for the researchers [13]. The preference of production methods can be an important element in formative the efficiency of the photovoltaic cell as studies. There are a lot of methods of synthesizing semiconductors metallic nanoparticles such as co-precipitation process, hydrothermal, combustion synthesis, Micro Emulsion, Microwave, Microwave process and sol-gel doling out etc [14], [15], [16].

In this research, sol-gel processing method was used to synthesize nanostructures; SiO doped $SrCl_2$ and $AgNO_3$ nanoparticles. There are no reported by any researcher related to SiO doped with $SrCl_2$ and $AgNO_3$ nanocomposites, especially in the form of photovoltaic cell. In this study, first of all prepared undoped silicon mono oxide nanoparticles among elevated photo active movement were synthesize by sol-gel technique. The sol-gel process is a adaptable procedure use for production a range of oxide resources as it allows extremely easy organize of particle dimension and the investigational procedure. Then pure SiO doped with $SrCl_2$ and $AgNO_3$ NPs for the performance of inorganic photovoltaic cells. $AgNO_3$, $SrCl_2$ doped SiO have construct effectively, and the consequence of Sr replacement on the Solar Cell formation and its photovoltaic possessions has investigated in specify by X-ray diffraction (XRD), Field emission scanning electron microscopy (FE-SEM), Energy Dispersive Spectroscopy(EDs), Fourier Transform Infrared Spectroscopy (FTIR).

II. EXPERIMENT

A. Materials and Methods

All the required materials and solvents are commercially available and were without further purification. Chemicals used in this work were Silica [Si], acetic acid [CH_3COOH], methyl acetate [$C_3H_6O_2$] and methanol [CH_3OH] (purity > 77 99%), were bought from Sigma-Aldrich. Silicon dioxide (SiO_2) nanoparticles were synthesized by sol-gel technique. Silver nitrate [AgNO3]. Strontium chloride [SrCl2] (purity > 99%), benzyl alcohol (C6H5CH2OH); ethanol (C2H6O) and acetyl acetone (C5H8O2) were bought from Sigma-Aldrich and Merck.

B. Sample preparation

a. Pure Silicon Mono Oxide Nanoparticles

In this study, first of all we organized pure silicon mono oxide nanoparticles with elevated photo induced action were synthesized by sol-gel technique. In this process 10 ml of methanol were dissolved in 1 ml of acetic acid, and shake for 2, 3 minutes at room temperature. Immediately 7 to10 drops was added of Si at the time, stirring the solution for 2 hours, after that a transparent solution has been obtained. Organized SiO_2 solution were dried at room temperature and grind and calcined at 500C. SiO_2 nanoparticles is prepared, further process for fabrication of SiO, Nanoparticles of SiO_2 was insert into a zirconia boat and does thermal treatment at ca.1700c in standard tube furnace under flowing argon, then obtain material were cooled and uninvolved from furnace and put down by the side of the furnace walls as a brown, ground to a homogeneous powder with a mortar.

b. Preparation of Modified Doped Nanocomposites

The $SrCl_2$ doped SiO NPs were organized using via acid adapted sol-gel technique. During the first step, strontium chloride 0.04 mol % were dissolve in 60 ml of deionized water at ambient air temperature follow by adding up 5 ml of glacial acetic acid and in the next step 10 % SiO was dissolve in 40 ml of anhydrous ethanol among stable stirring. Then, the both solutions were adding drop by drop, steady stirring the solution. Consequently, the received sol be stirred continuously for 3 hours and matured for 3 days at air temperature. As-ready SiO gels were dehydrated for 12 hours at 80^0

C. The received solids were ground and lastly calcined at 500^0C for 2h (heating rate = 3^0C/min). The undoped SiO nanoparticle is ready via the similar technique for proportional purpose. The undoped SiO, $AgNO_3$ doped SiO nanoparticle was arranged via the similar process for proportional purpose.

c. Characterizations

X-ray diffraction studies (XRD), Bruker D8 Advance mechanism by Cu Kα X-ray energy concerning 0.154 nm was engaged to charge the structural veracity with a diffraction pattern were in use greater than the 2θ range 20°–80° by step scan among a step dimension of 0.02°. X-Ray diffraction investigation (XRD) is a non critical method that provide complete in sequence regarding the crystallographic organization, chemical constitution, and physical qualities of a substance. The phase identification of the powder sample analysis was considered by X-ray diffraction (XRD) via an ultima IV X-ray diffractometer. Fourier Transform Infrared Spectrum (FTIR) deliberate was approved out in suitable example by Bruker Alpha FTIR spectrophotometer contained by a range of 400–4000 cm^{-1}. Using of 4 cm^{-1}. An average of 16 scans was performed for each sample. FTIR spectroscopy was employed to characterize the formation of the samples of doped nanoparticles. JEOL JSM-7610F FE-SEM system to examine the morphology of the samples, a field emission scanning electron microscope (FE-SEM) with energy-dispersive x-ray spectroscopy (EDs) and EDs mapping investigation was used.

III. RESULT AND DISCUSSION

X-ray diffraction is a precious process for studying crystal structure and calculating the crystalline size of created NPs [17]. As indicate in Fig. 1 (a, b, c) the crystal phase structure of formed materials combined with silicon mono oxide is first determined using XRD fig (a) indicates the XRD pattern and it expresses 4 major attribute diffraction peaks for SiO at 2θ angle of 28.1, 35.3, 64.7 and 77.7, which correspond to crystal planes (111), (200), (220), and (370), in that order. In all XRD results, the sharp peak centered on 26.70° can be certified to silicon mono oxide (002) [18]. The resources polycrystalline environment is indicating via the band. SiO doped $AgNO_3$-$SrCl_2$ at diverse originator temperatures. The nanopowder have a well-built peak at (105) and (280) which correspond to 2theta standards of 47.69° and 23.77° for undoped SiO and doped SiO correspondingly, and a great crystalline peak with a cubic phase indexed at (100), (102), (103), and (229) directions. SiO-doped $AgNO_3$-$SrCl_2$ photovoltaic cell indicates the adequate inorganic photovoltaic cells distinctiveness than undoped SiO photovoltaic cells [19].

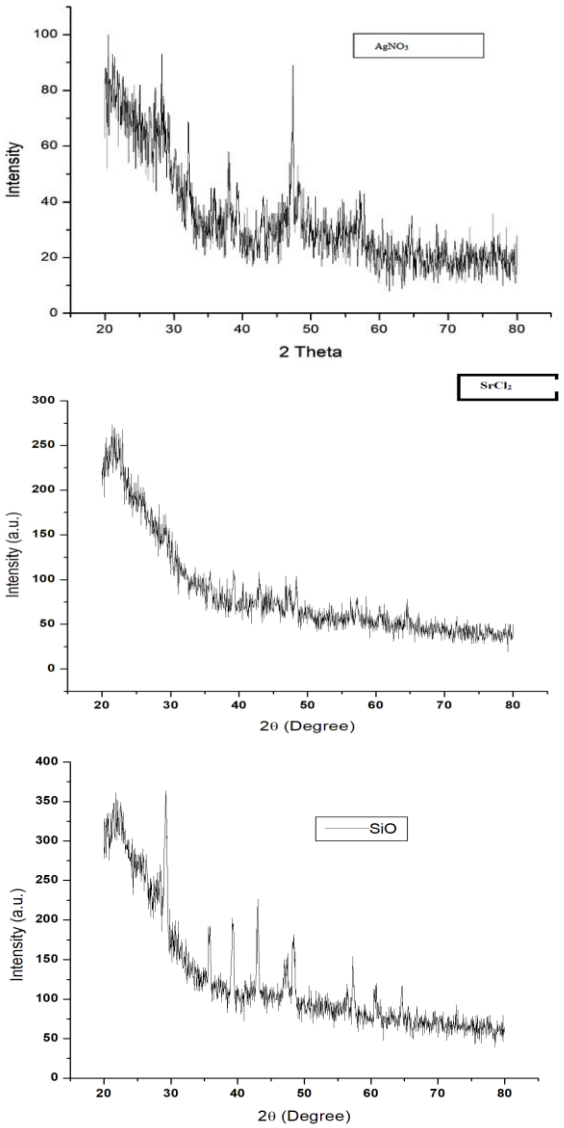
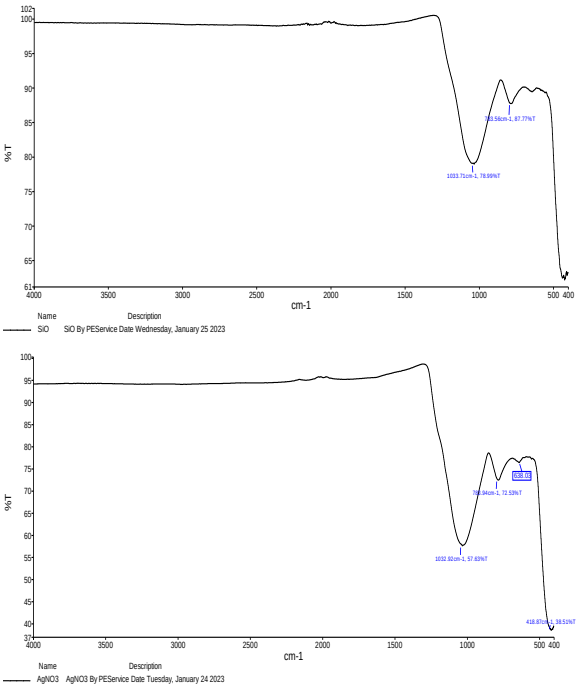


Figure 1: XRD spectra of (a) pure SiO (b) $AgNO_3$-SiO, (c) $SrCl_2$-SiO.

The FTIR Spectra for pure SiO and doped SiO/$AgNO_3$-$SrCl_2$ are exposed in fig.2 (a), (b) and (c). The diverse bond and efficient groups fascinated at diverse wavelengths; an infrared range is use to conclude the organization of inorganic molecules. The

peaks of α-phase SiO appear at 400, 520, 680, 890 and 1340 cm^{-1}. Where the absorption band at 783.56 cm^{-1} and 1033.71cm^{-1} is attribute of β phase and to some extent shifted towards inferior wave number as the particle size is condensed. The peak at 400 cm^{-1} corresponds to asymmetric indirect and individuals at 550 cm^{-1} to stretching vibrations in SiO. While this energy is weedy Corresponding peaks of SiO is 375, 240, 260, 285, 245, 175, and 150. The two sturdy bands 1,033 and 84 cm−1 pragmatic are connected with asymmetric and symmetric Si–O–Si stretch ambiance, in that order. This confirms that the SiO phase is shaped. Doped SiO/$AgNO_3$ absorption band at 57.63%, 38.51%, 72.53% and for doped SrCl2 86.90%. The region as of 1100 cm-1 to 400 cm-1 is call the efficient collection section [20]. The bands in this area are mainly functional in formative the type of efficient groups in attendance in the molecule. The response among originator resources of equally pure and doped SiO nanopowders is arranged by sol-gel method. We have established the SiO doped $AgNO_3$-$SrCl_2$ inorganic photovoltaic cells method to complete elevated competence photovoltaic cells with stumpy cost.



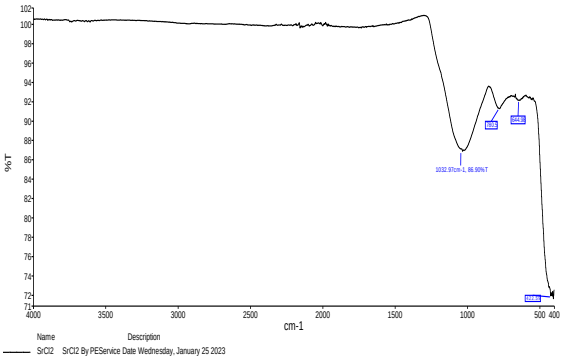


Figure 2: FTIR analysis (a) pure SiO (b) $AgNO_3$- SiO, (c) $SrCl_2$-SiO.

The morphology of the pure SiO and doped SiO/$AgNO_3$_$SrCl_2$ is studied via FE-SEM as represent in Fig.3 (a, b, c). [1]. consequently, these materials have almost equal FE-SEM images, a large amount probable due to their equivalent structures. The doped $AgNO_3$_$SrCl_2$ nanoparticles and pure SIO reveal an exclusive morphology of round shapes with exceptional pointed edges, with particle sizes in the nanometer range. The particle allocation is fine, and there is no increase, representative that silicon mono oxides are directly bonded to C with separate phase. The value of the doped $AgNO_3$_$SrCl_2$ generate by the sol-gel technique was also check by FE-SEM technology. Fig. 3 consequences create that the standard particle size of pure SiO and doped SiO/$AgNO_3$-SrCl2 was 15.0 micrometer. This is essentially not the dimension of pure SiO and doped SiO powder nano composites but this show collects of nanoparticles. The representation of pure SiO and doped SiO/$AgNO_3$_$SrCl_2$ particles magnification at 15.0x, 19.0x, 43.0 xs is shown in fig.3. (a), (b), (c) and for identical variation 0.04mol [21]. The benefit of the SiO/ $AgNO_3$_$SrCl_2$ and SiO electrodes in PCs to create non-porous, dense, and straight which enhancing photovoltaic cells performance is confirmed by these structural and morphological analyses. Also, a cross-sectional FE-SEM image of the most advantageous appliance is shown in Fig. 3 where the entity composite of pure SiO and doped SiO-$AgNO_3$_$SrCl_2$ can be renowned with thicknesses of ∼10 μm for pure SiO and SiO-$AgNO_3$ and ∼1 μm for SiO -$SrCl_2$ respectively.

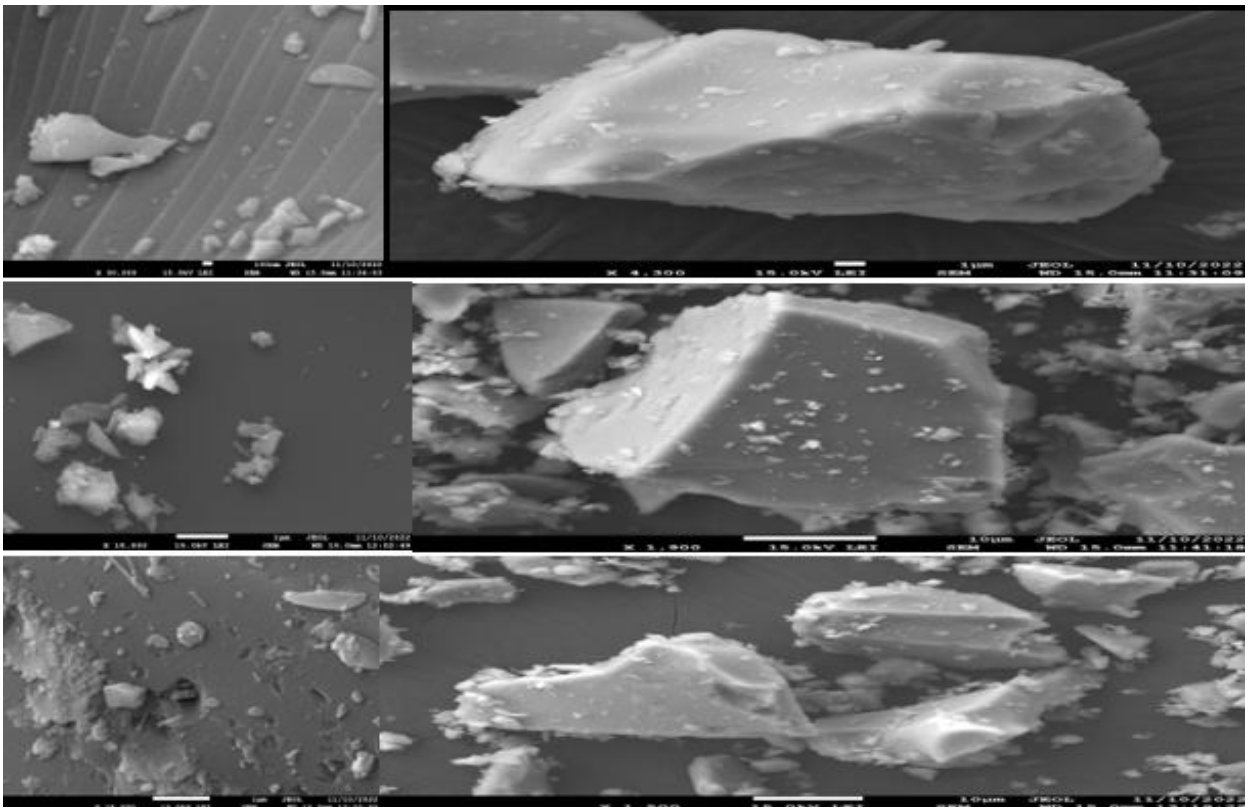
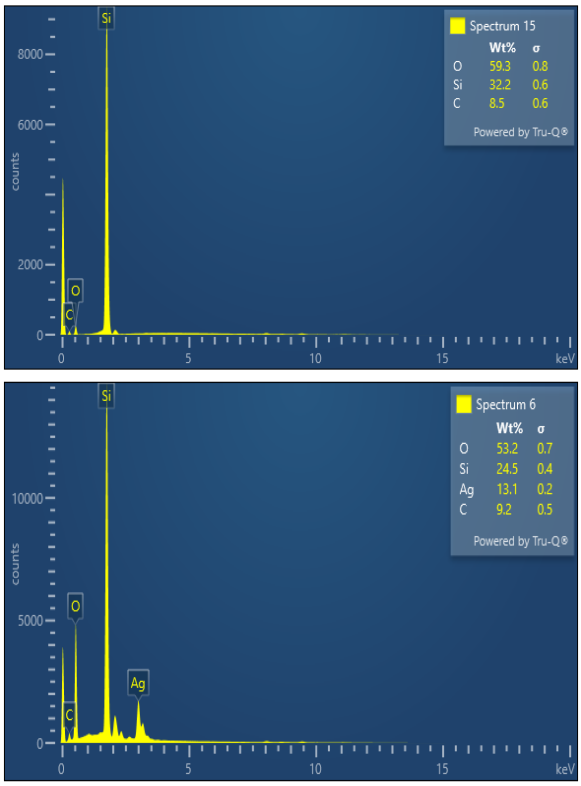


Figure 3: FE-SEM analysis (a) pure SiO (b) $AgNO_3$- SiO, (c) $SrCl_2$-SiO.

The partially quantification of elemental investigation to discover the sample be complete via power dispersive X-Ray spectrometer (EDS) JEOL model JSD-5610LV through an accelerate electrical energy of 15kv. The outcome of energy dispersive shows study of pure SiO and doped SiO nano powder are in the fig.1233. Trace elements are probable such as Si, C, & O present in the samples. In pure SiO absorption of Si is 32.2% and absorption of oxygen is 59.03%. This consequence gives to the Si, O and C present in sample. Doped SiO 13.1% of silver present in the samples and strontium is not present in the sample. EDS mapping descriptions of pure SiO and doped SiO-$AgNO_3$_$SrCl_2$ nanocomposites. The elements associated to each one arrangement are consistently circulated contained by the carbon coating, confirm the standardized division of metal oxide. Also, ED's descriptions were composed to authenticate the elemental delivery, as revealed in fig. 4 (a), (b), (c). A straightforward crushing procedure distributes shaped nanoparticles in carbon coated.



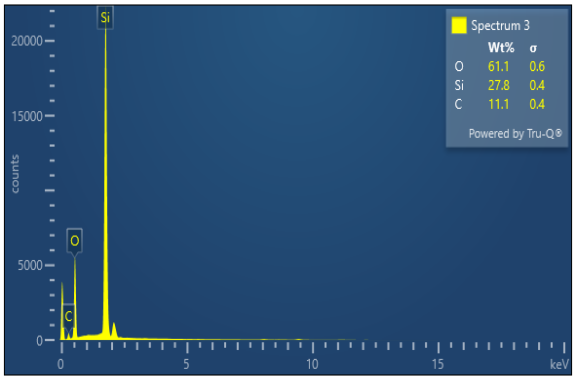


Figure 4: ED's analysis (a) pure SiO (b) $AgNO_{3}$- SiO, (c) $SrCl_2$-SiO.

IV. CONCLUSION

We have verified the sio doped AgNO3-SrCl2 inorganic photovoltaic cells performance to accomplish high competence solar cells with low cost. In The results we have discussed about the great probable of the PCs silicon functional in photovoltaic cells manufacturing as the after that production substrate. The narrative technical originality for a short time investigate a easy and cost efficient way to improve the optical, physical and electrical property of a silicon solar cell by embed Ag Nps though the weight optical model purpose furthermore spectroscopic investigations recommend that the entrenched Ag Nps layer by stumpy temperature method ones silicon wafer shaped by means of quick thermal dispensation can boost brightness trap competence this in a straight line help great scale mass scale. Doped and undoped NPs be characterize by X-ray diffraction, field emission scanning electron microscopy, energy-dispersive x-ray spectroscopy and FTIR technique are used to categorize the synthesized Nps of SiO and doped AgNO3_SrCl2 provide as unique characteristics for Inorganic Photovoltaic cells. XRD pattern and it exhibit four main quality diffraction peaks for SiO at 2θ angle of 28.1, 35.3, 64.7 and 77.7, which correspond to crystal planes (111), (200), (220), and (370), in that order. In all XRD results, the sharp peak centered on 26.70° can be certified to silicon mono oxide (002). The FTIR peaks of α-phase SiO come into view at 400, 520, 680, 890 and 1340 cm-1. while the incorporation band at 783.56 cm-1 and 1033.71cm-1 is feature of β phase. The peak at 400 cm-1 correspond to asymmetric twisting and individuals at 550 cm-1 to stretching vibrations in SiO. EDs shows trace elements are probable such as Si, C, & O present in the samples. The doped AgNO3_SrCl2 nanoparticles and pure SiO reveal an exclusive morphology of round shapes with exceptional pointed edges, with particle sizes in the nanometer range. AgNO3 surrounded in a dielectric substance have well-built diffusion properties under radiance enlightenment. SrCl2 because it is semiconductor quantum dots, high yield of luminescence properties they absorb light during the day and release it slowly for hours after wards. This enhancement can also be associated to the superior quality of the Inorganic Photovoltaic cells (PCs) employed in the study. The purpose of this work is to put on more imminent among the optical properties of pure SiO and doped AgNO3_SrCl2 nanoparticles and their influence on the concert of photovoltaic cells.

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