Idea for synthesis of Hybrid quantum dots thin film for solar cell application

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***Abstract* - Hybrid quantum dots are promising candidate for fabricating next generation solar cell application due to their promising optical properties. Over the last few years, their wide applications are in optoelectronics such as photodetectors, light-emitting diode and photovoltaics. Recently, some QD based solar cell has shown its efficiency (PCE) of 13.8% due to surface passivation and device structure. Among the nanostructure, quantum dots are great interest in optoelectronics industries due to its size dependent effect. Basically, there is some problem to select the parent materials for synthesis quantum dots for solar cell fabricating application. In order to address and solve the crisis problem, here ZnO, FeS_2 and Se semiconductors will be used. These materials offer great advantages for optoelectronics properties alignment (Fermi level, band edge and band gap). Hence, the optoelectronics properties will be alignment on selected semiconductor materials for potential use in thin film solar cell. Therefore, the aim of this work is to develop the semiconductor (ZnO:K, FeS_2 and Se) hybrid quantum dots thin film for fabricating thin film device for solar energy harvesting application.**

I. INTRODUCTION

Nowadays, solar energy is an amazing candidate for addressing crisis in global energy and eventually assists for reducing carbon emission. Still, there exists a great challenge among researchers to develop the thin film for photovoltaic with more friendly at reduced cost of renewable energy device and global warming [1 **Peng Yu**]. Moreover, there are limited availability of sources such as fossil coal, hydropower, nuclear and biomass. Solar energy is only most abundant and sustainable source to fulfill the demand of global energy. For decades, organic and inorganic thin films have been utilized for improving the more solar efficiency.Recently, inorganic quantum dots have been fabricated for light absorber to replace conventional materials because quantum dots thin film exhibits desired properties and shown 66% efficiency [1-5]**.** However, its efficiency suffers by imperfect alignment of optoelectronics properties such as Fermi level, band edge and energy level. Novel nanostructure has been focused for various applications. The quantum confinement effect in three dimension that can modify the optical properties. The unique optical properties of semiconductor quantum dots has been emerged for wide range of applications especially for solar energy harvesting. Therefore, optoelectronics properties of inorganic quantum dots have to alignment with perfect size and shape for best solar efficiency.

II. COATING TECHNIQUE

To date, several sophisticated techniques and methods have been employed for making the thin film for solar cell device application. Moreover, rf sputtering, spin coating and spray pyrolysis techniques offers more advantages for developing thin film **[6].** Among the different sophisticated techniques, rf magnetron sputtering has become the choice for deposition of all kind of semiconductors. Hence, rf magnetron sputtering was used extensively in semiconductor industries for optoelectronics device fabrications. It has some favorable advantages such as large area coating, high density, high quality and high adhesion [8**]**. Following it, the spray pyrolysis technique is one of the main for thin and thick films developing. Moreover, the spray pyrolysis offers desired advantages for developing thin film of various material compositions. Even stack layer thin films can be easily prepared by spray pyrolysis technique. Therefore, the spray pyrolysis technique has been used in various optoelectronics especially solar cell industry. Moreover, the spin coating is currently major technique to develop uniform thin film with various layer thicknesses in the order of micrometer to nanometer range. Therefore, the spin coating was also employed more than fifty years in thin film technology. The technique has also been employed in manufacturer of optical mirror, color television screens and magnetic disk for data storage **[7].** The present all techniques contains more preferred advantages in thin film developing. Hence, radio frequency sputtering, spin coating and spray pyrolysis will be used to develop the hybrid quantum dots thin film.

Several semiconductor candidates have been developed and tried for improving solar efficiency. In thin film solar industries, crystalline silicon, Cu_2S, a-Si, m-Si,n-Si, CdTe, CIGS,CNTS, concentration solar cell such as Si, GaAs and other dye, Organic and hybrid solar cells have been developed. However, those candidates have some challenging problems such as toxic, expensive, imperfection optoelectronics properties and efficiency degradation which restricts their efficiency. Moreover, these materials loses their efficiency by poor stability, poor durability, low charge carrier mobility, high operating temperatures, low exciton binding energy, degradation and photon lack**.** Following them, Since few years, quantum dots based thin film solar was emerged (66 % efficiency) than others due to their size and shape effect. However, their efficiency was also suppressed by non - alignment optoelectronics properties (Fermi level, band edge and photon trapping). Therefore, if optoelectronics properties will construct perfectly with size and shape that the maximum energy efficiency can be achieved.

Among the nanostructure, quantum dots are great interest in optoelectronics industries due to its size dependent effect. Recently, quantum dots has shown 66% solar energy efficiency. This indicates that the great advantages of semiconductor quantum dots. In order to address and solve the crisis problem, ZnO, FeS_2 and Se semiconductors will be used. These materials offers great advantages for optoelectronics properties alignment (Fermi level, band edge and band gap). Hence, the optoelectronics properties will be alignment on selected semiconductor materials for potential use in thin film solar cell. Therefore, the aim of this work is to develop the semiconductor (ZnO:K, FeS_2 and Se) hybrid quantum dots thin film with perfect optoelectronics properties alignment to improve solar energy efficiency.

The objectives of this work is to develop the hybrid quantum dots thin film on ZnO, FeS_2 and selenium for solar energy application. Zinc oxide, Pyrite and selenium semiconductors are much suitable for improving solar efficiency. Zinc oxide contains wide band gap (3.37 eV), acceptable large exciton binding energy (60 meV) and n-type behavior good optoelectronics properties at room temperature. Moreover, ZnO becomes more stable and electron mobility μ_e = 200 $cm^2V^{-1}s^{-1}$ and make it attractive for thin film solar cell. FeS_2 has high electron mobility, high optical absorption coefficient (10^6 cm^{-1} in the visible region),suitable band gap(0.95 eV), non-toxic, absorption coefficient (α 10^5 cm^{-1} , $\lambda \leq$ 700 nm), charge carriers concentrations 10^{18} cm^{-3} and electron and hole motilities 164 and 1.3 cm^2 v^{-1} S^{-1}, and electron carrier mobility is 360 cm^2 V^{-1} S^{-1}. Selenium also contains good capacity to absorb infrared below the band gap. In order to address and solve the mentioned crisis problems, hybrid quantum dots thin film will be constructed to determine the solar efficiency with perfect optoelectronics properties alignment. Hence the main objective of this proposal is to develop the new hybrid ZnO:K, FeS_2 and Se quantum dots thin film for best solar performance.

III. Synthesis and Device fabrication

Materials and experiment work

Here, Zinc chloride, potassium acetate, deiniozed water will be used to prepare K doped ZnO quantum dots. Hydrated ferric nitrate Fe $(NO_3)_3 \cdot 9H_2O$,2-methoxythanol and acetyl acetone will be used for synthesis of FeS_2 quantum dots. Selenium quantum dot will be used along with ZnO and FeS_2. In the thin film fabrication section, glass, quartz and tin oxide substrates will be used. Acetone, methanol and demonized water will be used to clean the substrates. Rf sputtering, spin coating and spray pyrolysis techniques will be used to fabricate the quantum dots thin films.

IV. COCLUSION

In this work, highly efficient hybrid semiconductor quantum dots thin film is focused to attain the maximum efficiency. The main physical parameters such as (i) Thickness (ii) Particle size (iii) optoelectronics properties (band edge, Fermi level, energy gap and photon trapping structure) and (iv) Stability will be analyzed in the work. In the present work, ZnO:K, FeS_2 and Se does not exhibits toxic and expensive result in low cost and zero green house effect. Moreover, the present hybrid quantum dots thin film can be functioned at low sunshine. After incorporation of FeS_2 and Se along with ZnO:K are (i) efficiency stability will be improved (ii) Solar energy can be harvested at minimum light intensities and (iv) Can also be used under all environmental conditions. The hybrid quantum dots semiconductors thin film will be low cost, flexibility and stability. Therefore, the new hybrid semiconductor quantum dot thin film will be a new candidate in solar industries.

V. REFERENCES

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