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Nanocomposites for Solar Cell Application

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ABSTRACT

A nanocomposite material is constituted by a matrix and a reinforcement consisting of fibers. Solar cells are devices for converting sunlight into electricity. Their primary element is often a semiconductor which absorbs light to produce carriers of electrical charge.The structures of hybrid nanocomposites studied so far, and attempt to associate the power conversion efficiency with these nanostructures. Subsequently, to summarize the factors for optimizing the performance of inorganic/organic solar cells. There are few important methods for synthesis i.e. intercalation, in-situ polymerization, sol gel, direct mixing method etc. this work represents the review on synthesis, characterization of polymer nanocomposites for solar cell application.

Keywords: nanocomposites; polymer; solar cell.

I. INTRODUCTION

In a broad sense, the word "composite" means "made of two or more different parts". A nanocomposite is a composite material, in which one of the components has at least one dimension that is nanoscopic in size that is around 10^{-9} m.

The matrix itself comprises a resin and filter, the goal of which is to improve the characteristics of the resin while reducing the production cost. From a mechanical point of view the filter-resin system behaves as a homogeneous material, and the composite is considered as being made of a matrix and reinforcement [1]. Organic/inorganic nanocomposites are very promising for applications in devices such as light emitting diodes (LED), photodiodes, photovoltaic cells, and gas sensors.
Since the properties of a nanocomposites film can be easily changed by varying its composition, such materials are highly versatile, while their fabrication shares the some advantages with traditional organic device technology, such as low cost production and the possibility of device fabrication on large area and flexible substrates [2]. As in case of the microcomposites, nanocomposites materials can be classified, according to their matrix materials, in following three different types.

Ceramic Matrix nanocomposites (CMNC):
For the preparation of ceramic matrix nanocomposites, many methods have been described. The most common method as, used for microcomposites, are conventional powder method, polymer precursor route, spray pyrolysis.
e.g. Al_2O_3/SiO_2, Al_2O_3 /CNT, Al_2O_3/SiC, etc.

Metal Matrix nanocomposites (MMNC):
The most common techniques for the processing the metal matrix nanocomposites are spray pyrolysis, liquid metal infiltration, Rapid solidification, vapour techniques, electrodeposition and chemical methods, while include colloidal sol- gel processes.
e.g. NiO/Al_2O_3, Co/Cr, Fe/MgO, Al/CNT, Mg/CNT

Polymer Matrix nanocomposites (PMNC):
The structure of polymer nanocomposites reinforced with isodimentional particles is similar to that of ceramic and metal nanocomposites.
e.g. Thermoplastic/Thermoset polymer silicates, polyster/TiO_2, polymer/CNT, polymer/layered double hydroxides etc. [3]. Advantages of nanocomposites are more and the possibilities for application in the packing industry are infinite (endless), the properties of

nanocomposites are chemical stability, high mechanical strength and thermal stability.

II. SYNTHESIS METHODS

1. Intercalation method:

Intercalation method generally involves the dispersion of nanoplatelets types of nanomaterial into the polymer matrix. It is well known that incorporation of clays into polymer matrices improves the bulk properties such as stiffness, shrinkage and flammability. The nanoplates can be homogeneously dispersed by the following two techniques.

Chemical technique: This technique involves the in situ polymerization method in which nanoparticles are dispersed in monomer and then polymerization reaction takes place. In this method, nanoplates are dispersed into polymer followed by additional polymerization process. The nanoplatelets are swollen in monomer solution and the polymer formation occurs between the intercalated sheets by polymerization method.

Mechanical technique: In this method direct intercalation of polymer with nanoplates takes place through solution mixing. The polymer is dissolved in a co-solvent and nanoplates sheets are swollen in the solvent and these two solutions are mixed together, the polymer chains in the solution intercalate into the nanoplatelets layers and displace the solvent.

2. In-Situ Polymerization method:

This is one of the specialized methods to involve the swelling of the nanofibers in monomer solution since the low molecular weight monomer solution can easily seeps in between layers causing swelling. The resulting mixture is polymerized between inter layers thereby forming either exfoliated or intercalated nanocomposites. In situ template synthesis is a similar method. In this method, the clay layers are synthesized in the presence of polymer chains. Both polymer matrix and clay layers are dissolved in the aqueous solution and gel is generally refluxed at high temperature. The polymer chains are trapped inside the clay layers and nucleation and growth of clay layers takes place on the polymer chains at high temperature. The only drawback of this process is that high temperature synthesis causes decomposition of polymer.

3. Sol-gel method:

Sol-gel method is a bottom up approach and it is based on an opposite principle than all the above method. The term sol-gel is associated to two relations steps, sol and gel. Sol is a colloidal suspension of solid nanoparticles in monomer solution and gel is the 3 dimensional interconnecting network formed between phases. In this method, solid nanoparticles are dispersed in the monomer solution, forming a colloidal suspension of solid nanoparticles (sol) they are interconnecting network between phases (gel) by polymerization reactions followed by the hydrolysis process. The polymer serves as a nucleating agent and promotes the growth of layered crystals. As the crystals grow, the polymer is seeped between layers and the nanocomposite is formed.

4. Direct mixing of polymer and nanofibers:

Direct mixing of a polymer matrix and nanofibers is a top down approach of nanocomposite fabrication and it is based on the breakdown the nanofibers during mixing process. This method is suitable for fabricating polymer matrix nanocomposite and it involved two general ways of mixing the polymer and nanofibers. One way is mixing a polymer in the absence of any solvents with nanofibers above the glass transition temperature of the polymer. This method is generally called melt compounding method. The other way involves mixing of polymer and nanofibers in solution. This method is generally called solvent method/solution mixing method.

- ✓ Melt compounding method
- ✓ Solvent method/Solution mixing method

III. APPLICATIONS

Organic/inorganic nanocomposites are very promising for applications in devices such as light emitting diodes, photodiodes, photovoltaic cells and gas sensors. Since the properties of a nanocomposites film can be easily changed by varying its composition, such materials are highly versatile, while their fabrication shares the some advantages with traditional organic device technology, such as low cost production and the possibility of device fabrication on large area and flexible substrates. Application of different organic-inorganic. The performance of a nanocomposites solar cell is improved compared to a pristine polymer one.

The majority of the work on nanocomposites solar cells still reports efficiencies as 0.1 per.

In nanocomposite solar cells containing either a nanoporous electrode/polymer junction or a nanoparticles/polymer bulk heterojunction, the electrons are injected from the polymer into the conduction band of the semiconductors, so that the polymer acts as a sensitizer and whole transport layer. The properties of TiO_2 nanocomposites were determined using UV-vis spectroscopy, fluorescence spectroscopy, and cyclic voltammetry. In the future, there is no doubt that these new generations of hybrid materials. Now a day's most of the hybrid materials that have entered the market are synthesized and processed by using conventional soft chemistry based routed developed in the eighties. The copolymerization of functional organosilanes. The encapsulation of organic components with sol-gel derived silica or metallic oxides. The organic functionalization of nanofilters, nanoclays or other compounds with lamellar structures.

IV. CONCLUSION

In present review, we summarized the different ways to synthesis the various nanocomposites for solar cell applications. These different methods shows the general idea and the important solar cell applications of the various nanocomposites. Out of different methods, we are reviewing the sol-gel synthesis methods in different research work. These methods shows the proper and desire results.

V. REFERENCES

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