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Composite Material of SnO_2 and Poly-Aniline

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Abstract: *This review article covers considerations on special the aspects of SnO2 with conducting polymer poly-aniline. Classical nano-composites formation technique, nano-composite properties electrical conductivity, thermal properties, optical properties as well as magnetic properties will be summarized. Typical existing and different applications will be shown with the focus on energy and environment systems.*

Keywords: *Poly-aniline, SnO2, Nano-composite, Electrical properties.*

1. INTRODUCTION

Polyaniline-SnO_2 composite material have been extensively investigated, this new typeof nano-composite material with different behaviors can be used in electronics field. SnO_2 is an n- type semiconductor while poly-aniline is p-type conductive polymer and Polyaniline is electro-conducting polymer containing a system of conjugated double bonds, and its properties combine semiconducting and metal physics with the molecular and solid-state chemistry, because it is flexible & environment stable. It's application is in many field such as battery electrode, anti-corrosion coating, Sensor. This type of composite materials is one kind of sensitive materials at, or near room temperature operating and attractive prospect of development, it is hopefully obtained that new type of composite material with different behavior between poly-aniline & nano SnO_2. There is a lot of study on composite materials of poly-aniline & nano SnO_2 reported, there is many researche work on it such as size & shape of oxide particle, degree of dispersion, SCHNETZUR ET AL have prepared the poly-aniline & nano SnO_2, characterized by thermal analysis, X-ray diffraction etc.

The resulting thermal, mechanical, optical, magnetic or conducting properties of the nanocomposites are influenced by the filler properties as well as from the fillers surface properties. Specific interest is to develop the polymeric nanocomposite with good thermo-mechanical properties, rheological characteristics and thermal stability for energy and environmental applications.

The nanostructured metal oxides are promising new materials for blending with polymers for obtaining low weight nanocomposites with excellent mechanical, electrical, thermal, and multifunctional properties. The creation of nanocomposites based on electro-conductive polymers and nanostructured metal oxides, i.e. incorporation of inorganic filler into polymer matrixes, can dramatically improve their processibility.

2. CONDUCTIVE POLYMER

The biggest advantage of conductive polymers is their working process, which is by dispersion. Conductive polymers are generally not plastics & thermo-formable. But, like insulating polymers, they are organic materials. They can produce electrical conductivity but do not show mechanical properties as other commercially used polymers do. The electrical properties can be fine tuned using the methods of organic synthesis and by advanced dispersion techniques . The linear –backbone "polymer blacks" (Polyacetylene, Polypyrrole, and Polyaniline) and their copolymers are the main class of conductive polymers. Historically, these are known as melanins(fig1.1) Poly (p-pheylene) (PPV) and its soluble derivatives have emerged as the prototypical electroluminescent semiconducting polymers. Today, Poly (3-alkylthiophenes) is the archetypical materials for solar cells and transistors.

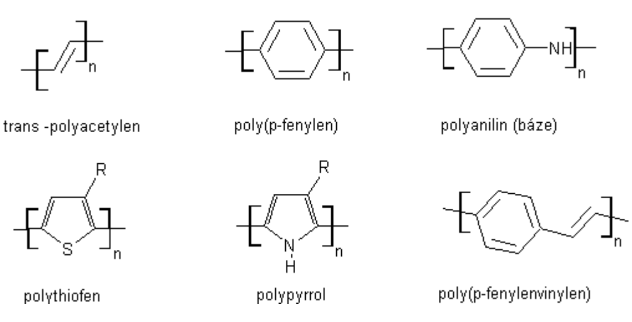

Fig. 1.1: Poly Aniline Structure

3. POLY-ANILINE

Poly-aniline (PANI) is a conducting polymer of the semi-flexible rod polymer family. This interest is due to the rediscovery of high electrical conductivity, Polyaniline and the other conducting polymers such as polythiophene, polypyrrole,and PEDOT/PSS have potential for applications due to their light weight, conductivity, mechanical flexibility and low cost. Polyaniline is especially attractive because it is relatively inexpensive, has three distinct oxidation states with different colors and has an acid/base doping response.A conducting polymer, polyaniline, was prepared in globular and nanotubular morphologies. The protonated forms were converted to the corresponding bases and both types of samples were tested for cytotoxicity. The polyanilines were then suspended in *N*-methylpyrrolidone or in concentrated sulphuric acid, and the soluble parts were precipitated into methanol acidified with sulphuric acid [5].Attractive fields for current and potential utilization of polyaniline is in antistatics, charge dissipation or electrostatic dispersive (ESD) coatings and blends, electromagnetic interference shielding (EMI), anticorrosive coatings, hole injection layers [6].

4. NANO-SNO_2

Metal oxides possess exceptional potential as base materials in emerging technologies. In recent times, significant amount of research works is carried out on these materials to assess new areas of applications, including optical, electronic, opto-electronic and biological domains. In such applications, the response and performance of the devices depend crucially, among other factors, on the size, shape and surface of the active oxide materials. For instance, the electronic and optical properties of oxides depend strongly on the spatial dimensions and composition. Tin oxide (SnO_2) is one such very important n-type oxide and wide band gap (3.6 eV) semiconductor. Its good quality electrical, optical, and electrochemical properties are exploited in solar cells, as catalytic support materials, as solid-state chemical sensors and as high-capacity lithium-storage. Previously, CHOPRA ETAL reviewed different aspects of transparent conducting SnO_2 thin films. WANG ETAL discussed device applications of nanowires and nanobelts of semiconductor oxides, including SnO_2. B ETAL discussed about the surface of single crystalline bulk SnO_2. However, it is understood that neither there is any comprehensive review on various crystallographic phases, polymorphs, bulk modulus, lattice parameters and electronic states of SnO_2, nor there is any updated compilation on the recent progress and scope on SnO_2nanostructures. Therefore, the proposed review covers the past and recent progress on the said topics and is summarized in the following manner. The available theoretical and experimental works on crystal structures, bulk modulus, lattice parameters are reviewed in details. The electronic states and the band structures of these phases are discussed next. Active crystal surfaces of SnO_2 play vital roles in its many interesting properties, including sensing and catalytic applications. So, a short review is written on its different surfaces, its electronic structures and density of states. The discussion on the importance of morphological variations on the properties of SnO_2 is followed by a review on different methods for obtaining such structures. A detail survey on the existing literature on techniques and mechanisms for the growth of nanostructures are included. SnO_2 is efficiently employed in gas sensing applications. A review on such applications is compiled based on the role of morphology and performance. The future course of SnO_2 as an important material in the contemporary research is also discussed.

5. SYNTHESIS OF POLY-ANILINE NANO-COMPOSITES:

Fabricationofpolyaniline,PANI,nanostructure isof importance for application [11] and hasleadalotofmethodsdeveloping. Accordingtoliterature,PANInanostructurescouldbepreparedusi ng the emulsion polymerization [12], solution polymerization [13] surfactant-assisted synthesis [14], electrochemical method [15], inter- facial polymerization, seedpolymerization, templateor template-freemethod andelectro-synthesis. Among these methods,theelectro-synthesisshowedadvantagesinsimple preparationprocedure,accuratecontroloftheinitiationandtermi-nationsteps,andformedpurerPANIthanthatfromchemical methodsduetotheabsenceofadditionalspecies.

6. SYNTHESIS OF NANO SNO_2:

Micro andNanostructuresofmetaloxidesemiconductors have attractedagreatdealofattentionduetotheirwidevariety of applicationsinelectronic,opticalandsensor fields. Nano-structuresofsemiconductingoxidesuchasSnO2, ZnO, and TiO2 have becomethesubjectofintensiveresearch. Among themetaloxides,SnO2, ann-typewidebandgap semiconductor, hasbeenextensivelystudiedformany potential applicationsinvarious fields includingcatalysts,batteries, solar cellsandgassensors.Thus,inrecentyears,significant effortshavebeenfocusedonthesynthesisofSnO2 nanostructures.Incontrasttonanoparticles,nanostructuressuchas nanobeltsandnanowiresofferhighlyenhancedperformancein catalysts andgassensorsduetotheirhighersurface-to-volume ratio. Hitherto,SnO2 nanowires havebeensynthesizedby techniquessuchashydrothermalgrowth [16], thermal evaporation [17], chemicalvapordeposition [18] and pulsedlaser deposition [19]. Amongthesetechniques, thermalevaporation technique isveryattractiveowingtoitssimplicityandlow cost. Inthecommercialthermalevaporationtechnique,a furnaceutilizeselectricpowertogenerateahightemperature which wouldsuffice tomeltandvaporizemetalprecursor.This method consumessignificant amountofelectricity.

7. PROPERTIES OF SNO_2

SnO2)isanoxidethatbelongstothesocalledtransparentconducti ngoxides (TCOs). Ithasadirectband-gapwhich wid thise qualto3.6eV[20].Itsapplicationsamongothersincludesolarene rgypanels,low-emissionglassesandheatmirrors[21].

NatureofthepropertiesoftheSnO2crystalsdependondifferentk indofdefectsandimpuritiesthatarepresentinthestructureofthis material.Thesedefectscouldaffectitsstructural,electronic,opti caland/ormagneticproperties.Thatmeansastrongnecessitytounderstandthenatureofthealterationsbeingproducedbythepointdefectsinordertosucceedinsuccessfulapplicationofthetindioxide.Thepresentworkhasthepurposetounderstandbetterwhatishappeningatthefundamentalquantumlevelinthiscrystalifsomeimpuritiessuchasfluorine,gallium,aluminiumandchromiumareincorporatedintheotherwisepurematerial

8. PROPERTIES OF POLYANILE

Electrically conducting elastomer fibers based on natural rubber (NR) and up to 10% w/w polyaniline (PANI) in its emeraldine base (EB) form were fabricated by a wet spinning process. The resulting fibers at various PANI contents were doped by immersion in aqueous HCl solution, which converted the PANI to the electrically conductive emeraldine salt (ES) form. The morphology of the composite fibers was studied by scanning electron microscopy (SEM). PANI particles were inhomogeneously distributed in the NR matrix. The electrical conductivity of the fibers increased with the increasing PANI-ES content and leveled off at a value of around 10^{-3} S/cm at PANI-ES concentration of 5% w/w. The fibers retained most of their elasticity upon doping, while the tenacity was somewhat reduced. Gratifyingly, the electrical conductivity of the new elastomer fibers was preserved upon elongational deformation, even if strains as large as 600% were applied.

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