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PSGVP MANDAL'S

S.I.P. ARTS, G.B.P. SCIENCE & S.T.S.K.V.S. COMMERCE COLLEGE,
SHAHADA - 425409, (DIST.NANDURBAR), (M.S.), INDIA.

Principal: Prof. Dr. R. S. Patil, M.Sc., M.Phil., Ph. D.

E-mail : principal.shahada@gmail.com

Outward No. 1763 /2019-20

Date : 20 / 03 /2020

To,

Joint Secretary,

Western Regional Office,

University Grants Commission,

Ganeshkhind, Pune – 411 007

Subject: Submission of documents for Minor Research Project awarded to Shri. I. B. Chaudhari in the subject CHEMISTRY- Finalization of Account-Compliance of Deficiencies

Reference: 1) File No: 4747-673/13 (WRO) Date: 27 March 2014
2) 1297/2018-19 dated 6-8-2019

Respected Sir/ Madam,

Please find enclosed herewith documents for Finalization of Account-Compliance of Deficiencies against Final report of Minor Research Project entitled "**Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti-Corrosive coatings**", undertaken by Shri. I. B. Chaudhari of our college.

The financial assistance for the project is Rs. 3,12,500/- (**Rupees Three lakh Twelve Thousand Five Hundred only**) and amount of Rs. Rs. 3,12,500/- (**Rupees Three lakh Twelve Thousand Five Hundred only**) was sanctioned. Total actual expenditure incurred for this project is is Rs. 3,14,754/-

Please accept the documents and settle the case

Thanking you.

Yours faithfully,


(Prof. Dr. R. S. Patil)

Principal
PRINCIPAL
P.S.G.V.P. M's, Arts, Science &
Commerce College, SHAHADA
Dist. Nandurbar (Pin-425409)

**UNIVERSITY GRANTS COMMISSION
WESTERN REGIONAL OFFICE
GANESHKHIND, PUNE-411007**

**PROFORMA OF SUBMISSION OF INFORMATION AT THE TIME OF SENDING
THE FINAL REPORT OF THE WORK DONE ON THE PROJECT**

1. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR: Ishwar Babubhai Chaudhari and Shri S.I. Patil Arts, G. B. Patel Science and S. T. K. V. S. Commerce College, Shahada, District – Nandurbar (425409)

2. NAME AND ADDRESS OF THE INSTITUTE: Shri S.I. Patil Arts, G. B. Patel Science and S. T. K. V. S. Commerce College, Shahada, District – Nandurbar (425409)

3. UGC APPROVAL NO. AND DATE: 47-673/13 (WRO) Date: 27 March 2014

4. DATE OF IMPLEMENTATION : 01th June 2014

5. TENURE OF THE PROJECT : 01th June 2014 to 01th Dec 2016

6. TOTAL GRANT ALLOCATED : 3,12,500/-

7. TOTAL GRANT RECEIVED : 3,12,500/-

8. FINAL EXPENDITURE : 3,14,754/-

9. TITLE OF THE PROJECT: Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti-Corrosive coatings

10. OBJECTIVES OF THE PROJECT:

- Prepare mesoporous TiO₂ and TiO₂-conducting polymer (Polyaniline, Polypyrrole and Polythiophene) hybrid nanocomposites via hydrothermal technique *f*
- Prepare different compositions of the conducting polymer-TiO₂ hybrid nanocomposites.
- Physico chemical characterization of the prepared nanocomposites via XRD, UV-Vis, DRS, FT-IR Spectra and conductivity measurements. *f*
- The prepared nanocomposites were used in the field of photocatalysis, thermal diffusivity measurement, nonlinear optics and lasing.

11. WHETHER OBJECTIVES WERE ACHIVED: Yes

- Synthesis and characterization of Nano particles Pani is successfully done.
- Synthesis and characterization of Nano particles PPy is successfully done.

- Synthesis and characterization of Pani-TiO₂ nanocomposite is successfully done.
- Synthesis and characterization of PPy-TiO₂ nanocomposite is successfully done.

12. ACHIEVEMENTS FROM THE PROJECT:

The synthesis and characterized nanocomposites of TiO₂ material can be used as conducting polymers. Nanocomposite material composed of conducting polymers & oxides have open more field of application such as drug delivery, conductive paints, rechargeable batteries, toners in photocopying, smart windows, etc.

13. SUMMARY OF THE FINDINGS:

Significant scientific and technological interest has focused on polymerinorganic nanocomposites (PINCs) over the last two decades. The use of inorganic nanoparticles into the polymer matrix can provide high-performance novel materials that find applications in many industrial fields. Research in functional hybrid organic-inorganic materials is being mostly supported by the growing interest of chemists, physicists, biologists and materials scientists to fully exploit this opportunity for creating smart materials benefiting from the best of the three realms: inorganic, organic and biological. In addition to the high versatility in chemical and physical properties and shaping, hybrid nanocomposites present the paramount advantage to both facilitate integration and miniaturization, therefore opening a land of promising applications in many fields: optics, electronics, ionics, mechanics, membranes, functional and protective coatings, catalysis, sensors, biology, medicine, biotechnology, etc. The present work is mainly focussed on the synthesis, characterization and various application studies of conducting polymer modified TiO₂ nanocomposites.

Part 1 deals with a general introduction about hybrid nanocomposites, their different synthesis strategies and their properties and applications. Also contains a general introduction to photocatalysis by TiO₂, thermal diffusivity measurement by thermal lens technique, nonlinear optics, and lasing studies.

Part 2 describes the synthesis procedure of TiO₂ conducting polymer nanocomposites. This part also gives a brief description about the various techniques used for physico-chemical characterization. The polymer modified nanocomposites were also prepared via hydrothermal route. Prepared nanocomposite systems were characterized by XRD, FT-IR Spectroscopy, SEM-EDX, Thermogravimetric analysis and BET surface area. Conductivity measurements of the prepared systems were done using standard 4-probe method.

14. CONTRIBUTION TO THE SOCIETY:

Before going into details regarding processing, structure, properties and applications of the nanocomposites, let us look at the potentials of these systems and the general opportunities they provide. Ceramics have good wear resistance and high thermal and chemical stability. However, they are brittle. In this context, the low toughness of ceramics has remained a stumbling block for their wider use in industry. In order to overcome this limitation, ceramic-matrix nanocomposites have been receiving attention, primarily due to the significant enhancement on mechanical properties which can be achieved. For example, the incorporation of energy-dissipating components such as whiskers, fibers, platelets or particles in the ceramic matrix may lead to increased fracture toughness.

15. WHETHER ANY Ph.D. ENROLLED/PRODUCED OUT OF THE PROJECT: NO

16. NO. OF PUBLICATION OUT OF THE PROJECT: NIL



(Prof. Dr. R. S. Patil)

PRINCIPAL
P.S.G.V.P. M. A. Arts, Science &
Commerced College, SAHADA
Dist. Nandurbar (Pin-425409)




(Shri. I. B. Chaudhari)

Principal Investigator

UPLOADING CERTIFICATE

CERTIFICATE

This is certify that the Minor Research Project, titled "Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti-Corrosive coatings" awarded to Prof. Ishwar Babubhai Chaudhari has been completed and executive summary of the project has been uploaded on the college website. This certificate is as per the requirement under the prescribed Minor Research Project guidelines,


(Prof. Dr. R. S. Patil)
Principal
PRINCIPAL
P.S.G.V.P. M's, Arts, Science &
Commerce College, SIJAHADA
Dist. Hanumanter (Pin-425409)

Final Report (MRP)

PRINCIPAL INVESTIGATOR: Ishwar Babubhai Chaudhari, Shri S.I. Patil Arts, G. B. Patel Science and S. T. K. V. S. Commerce College, Shahada, District – Nandurbar (425409)

Title: “Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti-Corrosive coatings”

i. Brief objective of the project:

The main objective of the research work is the synthesis of different conducting copolymers and their applications in anticorrosive coatings.

1. Chemical and electrochemical synthesis of different conducting polymers and copolymers constituting polyaniline, polypyrrole, polythiophene etc. by oxidation of corresponding monomer(s) using aqueous as well as organic media.
2. Study on corrosion inhibition using conducting polymers and copolymers to enhance the efficiency.

ii. Work done so far and results achieved:

Introduction:

In recent years, intrinsic conducting polymers with conjugated double bonds have been attracted much attention as advanced materials. Among those conducting polymers, polypyrrole (PPy) is especially promising for commercial applications because of its good environmental stability, facile synthesis and higher conductivity than many other conducting polymers. PPy can often be used as biosensors [1,2], gas sensors [3,4], wires [5], microactuators [6], antielectrostatic coatings [7], solid electrolytic capacitor [8,9], electrochromic windows and displays, and packaging, polymeric batteries, electronic devices and functional membranes, etc. [10-12]. PPy coatings have an excellent thermal stability and are good candidate for use in carbon composites [13]. Furthermore, the electrochemical process parameters affecting the properties of the PPy coatings are also investigated [14]. PPy can be easily prepared by either an oxidatively chemical or electrochemical polymerization of pyrrole. However synthetically conductive PPy is insoluble and infusible which restricts its processing and applications in other fields. The problem has been extensively investigated and new application fields have also been explored in the past several years. For example, PPy-based polymers can be used to load and release drugs and biomolecules [15]. PPy-based polymer blends can protect the corrosion of

metals [16]. In the present investigations attempts were made to report on our observation of structure morphology, electrical and optical properties of polypyrrole thin films using the spin coating technique.

Progress in the field of materials science has taken a new lead since the advent of the nanocluster-based materials or nanocomposites. Nanoclusters are ultrafine particles of nanometer dimensions and whose characteristics are size dependent and are different from those of the atomic and bulk counterparts [16]. Recently nanocomposite materials have become one of the most extensively studied material all over the world as they have shown to possess several technological application such as effective quantum electronic devices, magnetic recording materials sensors etc [17]. Nanocomposites are as multiphase materials, where one of the phases has nanoscale additives and are originating from suitable combinations of two or more such nanoparticles or nanosized objects in some suitable technique, resulting in materials having unique physical properties and wide application potential in diverse areas. Novel properties of nanocomposites can be derived from the successful combination of the characteristics of parent constituents into a single material. Materials scientists very often handle such nanocomposites, which are an effective combination of two or more inorganic nanoparticles. They are expected to display unusual properties emerging from the combination of each component [18]. Organic-inorganic composites have attracted considerable attention as they can combine the advantages of both components and may offer special properties through reinforcing or modifying each other [19]. To exploit the full potential of the technological applications with good processability which has ultimately guided scientists toward using conventional polymers as one component of the nanocomposites, resulting in a special class of hybrid materials termed "polymeric nanocomposites". Significant scientific and technological interest has focused on polymerinorganic nanocomposites (PINCs) over the last two decades. The use of inorganic nanoparticles into the polymer matrix can provide high-performance novel materials that find applications in many industrial fields. As a result of the development in nanotechnology, inorganic nanostructured materials have been designed/discovered and fabricated with important cooperative physical phenomena such as superparamagnetism, size-dependent band-gap, ferromagnetism, electron and phonon transport. Yet, they typically suffer from high manufacture expense, and the shaping and further processing of these materials is often difficult and demanding or impossible. These materials are also intimate combinations (up to almost

molecular level) of one or more inorganic nanoparticles with a polymer so that unique properties of the former can be taken together with the existing qualities of the latter. Many investigations regarding the development of the incorporation techniques of the nanoparticles into the polymeric matrices have been published. In most of the cases such combinations require blending or mixing of the components, taking the polymer in solution or in melt form. According to their matrix materials, nanocomposites can be classified as ceramic matrix nanocomposites (CMNC), metal matrix nanocomposites (MMNC), and polymer matrix nanocomposites (PMNC). Organic polymerbased inorganic nanoparticle composites have attracted increasing attention because of their unique properties emerging from the combination of organic and inorganic hybrid materials. Generally, the resultant nanocomposites display enhanced optical, mechanical, magnetic and optoelectronic properties. Therefore, these composites have been widely used in the various fields such as military equipment, safety, protective garments, automotive, aerospace, electronics and optical devices. Moreover nanocomposite material composed of conducting polymers & oxides have open more field of application such as drug delivery, conductive paints, rechargeable batteries, toners in photocopying, smart windows etc [20]. Synthesis of polymer composites of core shell inorganic particlepolymer has attracted much research attention in recent years because of its properties [21]. In particular, the composites of core shell metal oxide particles-conducting polymer combine the electrical properties of the polymer shell and the magnetic, optical, electrical or catalytic characteristics of the metal oxide core, which could greatly widen their applicability in the fields of catalysis, electronics and optics [22]. Polymers are already widely used in the optoelectronics industry and are playing important roles in various applications. Therefore, the drawbacks of using inorganic nanostructured materials can be overcome by employing a polymer matrix to embed a relatively small content of inorganic nanoparticles. The integration of inorganic nanoparticles into a polymer matrix allows both properties from inorganic nanoparticles and polymer to be combined/enhanced and thus advanced new functions can be generated to the PINCs [23]. The PINCs are one kind of composite materials comprising of nanometer-sized inorganic nanoparticles, typically in the range of 1-100 nm, which are uniformly dispersed in and fixed to a polymer matrix. In this way, the inorganic nanoparticles are acting like ‘additives’ to enhance polymer performance and thus are also termed ‘nano-fillers’ or ‘nano-inclusions’ [24, 25]. Among various PINCs, there is a new class of PINCs comprised of a polymer matrix with

'transparent nano-fillers' that is usually fabricated by insitu polymerization for the formation of nanocomposite and sol-gel methods for the formation of nano-fillers. This class of material is also sometimes called polymer-inorganic 'hybrid/nanohybrid'.

Hybrid Materials and Nanocomposites:

The term hybrid material is used for many different systems spanning a wide area of different materials, such as crystalline highly ordered coordination polymers, amorphous sol-gel compounds, materials with and without interaction between the inorganic and organic units. The most wide-ranging definition is the following: a hybrid material is a material that includes two moieties blended on the molecular scale. Commonly one of these compounds is inorganic and the other one organic in nature. A more detailed definition distinguishes between the possible interactions connecting the inorganic and organic species. Class I hybrid materials are those that show weak interactions between the two phases, such as Van der Waals, hydrogen bonding or weak electrostatic interactions. Class II hybrid materials are those that show strong chemical interactions between the components. Because of the gradual change in the strength of chemical interactions it becomes clear that there is a steady transition between weak and strong interactions. For example there are hydrogen bonds that are definitely stronger than for example weak coordinative bonds [26]. The so-called hybrid organic-inorganic materials [27] are not simply physical mixtures. They can be broadly defined as nanocomposites with organic and inorganic components, intimately mixed. Indeed, hybrids are either homogeneous systems derived from monomers and miscible organic and inorganic components, or heterogeneous systems (nanocomposites) where at least one of the components' domains has a dimension ranging from some \AA to several nanometers. It is obvious that properties of these materials are not only the sum of the individual contributions of both phases, but the role of the inner interfaces could be predominant. The nature of the interface has been used to divide these materials grossly into two distinct classes [28]. In class I, organic and inorganic components are embedded and only weak bonds (hydrogen, van der Waals or ionic bonds) give the cohesion to the whole structure. In class II materials the two phases are linked together through strong chemical bonds (covalent or ionic-covalent bonds). Maya blue is a beautiful example of a remarkable quite old man-made class I hybrid material whose conception was the fruit of an ancient serendipitous discovery. Maya blue is a hybrid organic inorganic material with molecules of the natural blue indigo encapsulated within the channels of a clay mineral known as

palygorskite. It is a man made material that combines the color of the organic pigment and the resistance of the inorganic host, a synergic material, with properties and performance well beyond those of a simple mixture of its components. Paints are a good link between Mayas and modern applications of hybrids [29].

Properties and Applications:

There is almost no limit to the combinations of inorganic and organic components in the formation of hybrid materials. Therefore materials with novel composition– property relationships can be generated that have not yet been possible. Based on the increased importance of optical data transmission and storage, optical properties of materials play a major role in many high-tech applications. The materials used can reveal passive optical properties, which do not change by environmental excitation, or active optical properties such as photochromic (change of color during light exposure) or electrochromic (change of color if electrical current is applied) materials. Silica is preferred as the inorganic component in such applications because of its low optical loss. Other inorganic components, for example zirconia, can incorporate high refractive index properties, or titania in its rutile phase can be applied for UV absorbers. Functional organic molecules can add third order nonlinear optical (NLO) properties and conjugated polymers, conductive polymers can add interesting electrical properties. The enhancement of mechanical and thermal properties of polymers by the inclusion of inorganic moieties, especially in the form of nanocomposites, offers the possibility for these materials to substitute classical compounds based on metals or on traditional composites in the transportation industry or as fire retardant materials for construction industry [30]. Organic–inorganic hybrid materials do not represent only a creative alternative to design new materials and compounds for academic research, but their improved or unusual features allow the development of innovative industrial applications. Nowadays, most of the hybrid materials that have already entered the market are synthesised and processed by using conventional soft chemistry based routes developed in the eighties. Looking to the future, there is no doubt that these new generations of hybrid materials, born from the very fruitful activities in this research field, will open a land of promising applications in many areas: optics, electronics, ionics, mechanics, energy, environment, biology, medicine for example as membranes and separation devices, functional smart coatings, fuel and solar cells, catalysts, sensors, etc.

Hybridization with Conducting Polymers-A Fine way to tune the Photocatalytic Activity in the Visible Region

Polymers that conduct electric currents without the addition of conductive (inorganic) substances are known as "intrinsically conductive polymers" (ICP). Conducting polymers is a prospective class of new materials that combine solubility, processability, and flexibility of plastics with electrical and optical properties of metals and semiconductors. The discovery of conducting polymers opened up many new possibilities for devices combining unique optical, electrical, and mechanical properties. Conductive polymers or, more precisely, intrinsically conducting polymers (ICPs) are organic polymers that conduct electricity [31]. Such compounds may have metallic conductivity or can be semiconductors. The biggest advantage of conductive polymers is their processability, mainly by dispersion. Conductive polymers are generally not thermoplastics, i.e., they are not thermoformable. But, like insulating polymers, they are organic materials. They can offer high electrical conductivity but do not show similar mechanical properties to other commercially available polymers. Intrinsically conducting polymers, also known as "synthetic metals", are polymers with a highly conjugated polymeric chain [32]. For the discovery of conducting polymers, Alan J. Heeger, Alan G. MacDiarmid and Hideki Shirakawa were awarded the Nobel Prize in Chemistry in 2000. Typical conducting polymers include polyacetylene (PA), polyaniline (PANI), polypyrrole (PPy), polythiophene (Pth), poly(para-phenylene) (PPP), poly(phenylenevinylene) (PPV), polyfuran (PF), etc.

Conducting polymers are generally wide band gap semiconducting materials, which can be chemically doped, with resulting electronic properties ranging from insulating to near metallic. Environmental, energy sources and materials sciences are the three key projects of 21st century. One of them is the photocatalysis using oxide semiconductor, which is closely associated with those topics. Since 1977, conducting polymers (CPs) have drawn considerable interest because of their unusual electrical, optical and photoelectrical properties and their numerous applications in various fields. Recently, the preparation for the nanocomposites of CPs with inorganic nanoparticles has attracted many researchers' attention, aiming to obtain the materials with synergetic or complementary behaviours between the CPs and the inorganic nanoparticles. Because of their semiconductor energy level structure, broad absorption spectra and very high stability under irradiation of solar light, CPs can be used to photosensitize semiconductor oxides and to obtain the novel photocatalysts response to the visible light.

Conjugated polymers (CP's) with extend π - conjugated electron systems such as polyaniline, polythiophene, polypyrrole, and their derivatives, etc have shown great promises due to their high absorption coefficients in the visible part of the spectrum, high mobility of charge carriers, and good stability. The properties of delocalized conjugated structures in electron-transfer processes have been widely studied to show that they could effectively active a rapid photo-induced charge separation and a relatively low charge recombination. Furthermore, many CPs in their doped or undoped states are efficient electron donor and good holes transporter upon visible light excitation.

Polyaniline

Among conducting polymers, polyaniline has been a significant interest due to its high conductivity, good redox reversibility, and swift change in film colour with potential and high stability in air. Polyaniline is one of the most important conducting polymers because of excellent electrical properties, number of intrinsic redox states, possible processability, good environmental stability, successful combination of chemical & physical properties, as well as its numerous applications in practice. Polyaniline (PANI) is the first polymer of this kind to achieve world-wide commercial availability.

Polyaniline (PANI) exists in a variety of forms that differ in chemical and physical properties. The most common green protonated emeraldine has conductivity on a semiconductor level of the order of 100 S cm^{-1} , many orders of magnitude higher than that of common polymers ($<10^{-9} \text{ S cm}^{-1}$) but lower than that of typical metals ($>10^4 \text{ S cm}^{-1}$). Protonated PANI, (e.g., PANI hydrochloride) converts to a non conducting blue emeraldine base when treated with ammonium hydroxide [32].

Polypyrrole

Polypyrrole (PPy) is a chemical compound formed from a number of connected pyrrole ring structures. Polypyrroles are conducting polymers of the rigid-rod polymer host family, all basically derivatives of polyacetylene. Polypyrrole was the first polyacetylene-derivative to show high conductivity. Polypyrroles are also called pyrrole blacks or polypyrrole blacks. Polypyrroles also exist naturally, especially as part of a mixed copolymer with polyacetylene and polyaniline in some melanins. Polypyrrole is a conducting polymer that has attractive characteristics for the use as a radar absorbing material [33]. Polypyrrole (PPy) is a p-type semiconducting polymer

that has proven to be relatively highly conductive, easy to synthesize, and environmentally stable. PPy can be prepared by chemical, electrochemical, plasma and vapor phase [33] polymerization. In applications like coating dielectric materials (in this case optical plastic) the most suitable process is the in situ chemical polymerization, because it provides relatively high conductivity as well as suitable thickness and uniformity of the film. The main drawbacks of other methods are poor conductivity (plasma); need for conductive substrate, finite size of substrate, porosity, and uneven thickness of films (electrochemical); problematic adhesion of oxidant solution with substrate (vapour phase) [34].

Applications of Polypyrrole

Applications of PPy were essentially extended during last years and include now such different fields of science and technology as corrosion protection of metals, development of individual electronic devices e.g. diodes, metallization, electromagnetic interference shielding, biosensors, tissue engineering scaffolds, neural probes, drug-delivery devices, and bio-actuators [35].

- (1) It has been studied as a material for artificial muscles--a technology that would offer numerous advantages over traditional motor actuating elements.
- (2) Used to coat silica and reverse phase silica to yield a material capable of anion exchange and exhibiting hydrophobic interactions.
- (3) Used in the microwave fabrication of multiwalled carbon nanotubes, a new method that allows obtaining CNTs in a matter of seconds.
- (4) polypyrrole (PPy) was synthesized by vapour phase polymerization (VPP) and electropolymerization (EP) and these PPys were employed as counter electrodes in dye-sensitized solar cells.

Polythiophene

Polythiophenes and other conjugated polymers have attracted attentions because of their electronic and photonic properties. The π -conjugated electronic structure of these polymers facilitates the delocalization of the charge carriers upon doping and imparts high charge mobility. This delocalized electronic structure also leads to characteristic strong absorptions and emissions, in most cases in the UV-Vis. region. Since the original unsubstituted conjugated

polymers are not solution- or melt processable, flexible side chains are attached to improve processability. In addition to solubility and fusibility, the attachment of various substituents can modify other physical properties of conjugated polymers, and lead phenomena which are not observed in the original unsubstituted polymers. Polythiophenes consist of a chain of alternating double- and singlebonds like polyacetylene, however, each first and forth carbon atoms are connected by a sulfur atom forming a thionyl ring. Therefore the bond between the second and the third carbon atom get more single bond character than the other C-C bonds and consequently also the bonds connecting the thionyl rings are more of single-bond character. Due to this weaker mesomerization than in polyacetylene the band-gaps of polythiophenes are shifted to the blue and UV. Beside of their structure defining function the sulfur atoms will have also a direct influence on the electronic and optical properties of a polythiophene. Nevertheless the conjugation of the C-atoms will dominate the spectroscopic properties of the polythiophenes.

Scope of the present work

The current area of research interest includes the synthesis, characterization and applications of hybrid nanocomposites of TiO₂ with conducting polymers. Nanocomposite material composed of conducting polymers & oxides have open more field of application such as drug delivery, conductive paints, rechargeable batteries, toners in photocopying, smart windows, etc. The composites of core shell metal oxide particles-conducting polymer combine the electrical properties of the polymer shell and the magnetic, optical, electrical or catalytic characteristics of the metal oxide core, which could greatly widen their applicability in the fields of catalysis, electronics and optics.

MATERIALS AND METHODS

Introduction

Characterization of materials regarding composition, trace impurities, structural phase and crystallographic perfection is vital for repeated reproduction of materials with stringently defined specifications, their applications as well as for fundamental research [1, 2]. The synthesis and characterization of material is the first and foremost step during the experimental research in materials science. The quality of samples depends to a great extent on the synthesis method used. In addition, the proper selection of synthesis parameters helps to carry out desired properties in

the samples to be characterized along with desired potentials. Structure, surface morphology, grain growth, transport of electrons within material and magnetic properties depend on material synthesis. When a material is fabricated in the lab, how are we able to assess whether our method was successful. Depending on the nature of the material being investigated, a suite of techniques may be utilized to assess its structure and properties. Whereas some techniques are qualitative, such as providing an image of a surface, others yield quantitative information such as the relative concentrations of atoms that comprise the material.

1. Synthesis of Nano particles of PANi Doped With DBSA In HCl Medium (PANi)

Polymerization was carried out by the chemical oxidation of aniline in the presence of SDS and APS in an aqueous HCl (1N) medium, both played the role as dopant and oxidant respectively. SDS (0.1611 mol) was dissolved in 111 mL of HCl in a four-neck round bottom reaction flask under mechanical stirring in ice bath ($0 - 5^{\circ}\text{C}$) for 2 hours. Aniline (0.1611 mol, distilled under reduced pressure prior to use) was stirred in 10 mL of HCl for 30 minutes. The solution was then added drop-wised into the SDS solution with vigorous stirring for 3 hours to disperse the aniline homogenously, resulting a milky dispersion of particles anilinium-SA complex. The dispersion was stirred in an ice bath maintained at $0 - 5^{\circ}\text{C}$. A solution of APS (0.1933 mol, cooled prior to use) in 120 mL HCl was latter added drop-wised for 2 hours into the solution to initiate the aniline polymerization. The temperature of the solution was kept between $0 - 5^{\circ}\text{C}$ under vigorous stirring until the addition of APS solution was completed. The reaction was later carried out for 24 hours at room temperature with stirring. A dark green colored PANi suspension was obtained without precipitation. The synthesized PANi was obtained as finely dispersed particles, which were recovered from the polymerization mixture by centrifugation and washed with deionized water repeatedly until the washing liquid was completely colorless. Finally, the polymer was transferred to a beaker containing 1 N aqueous solution of protonic acid (HCl). After keeping overnight, the PANi was obtained by centrifugation and excess acid in PANi washed with deionized water and centrifuged each in sequence for several times. A portion of the resulting wet product was dried under vacuum at $60 - 80^{\circ}\text{C}$ for more than 8 hours.

2. Synthesis of PANI-TiO₂ nanocomposites :

The PANI-TiO₂ nano composites were prepared according to the following steps. 3 g of nanocrystalline TiO₂ particles, 1 ml of aniline and 90 ml of 1.0 M HCl aqueous solution were introduced into the reaction vessel. The solution was mechanically stirred for 1 h to obtain a uniform suspension containing TiO₂ particles, in an ice-water bath. After that, 100 ml of a precooled 1.0 M HCl aqueous solution containing 2.5 g of APS was added dropwise to the above cooled mixture over a period of approximately 60 min, and the resulting mixture was allowed to react in the ice bath for 4 h. The precipitated dark green-colored PANI/TiO₂ nanocomposite powder was filtered and washed with large amount of deionized water, then with 50 ml of ethanol and 30 ml of ether, after that the powder was extracted with ethanol in order to remove the oligomers till the extracted solution became colorless. Finally, the product was dried at 80 °C till the constant mass was reached. The samples were signed as PANI- TiO₂ nano composite.

The synthesized Nano particles of PANI was characterised by using scanning electron microscopy (SEM), transmission electron microscopy (TEM), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), FTIR and X-ray diffraction.

Characterization of Nano particle's of PANI

1. Scanning electron microscopy (SEM) of Nano particles of PANI:

The image of PANI seems to be uniform micro porous on the surface and the particles were in nanometer scale. The average particle size of PANI was found to be 50–100 nm.

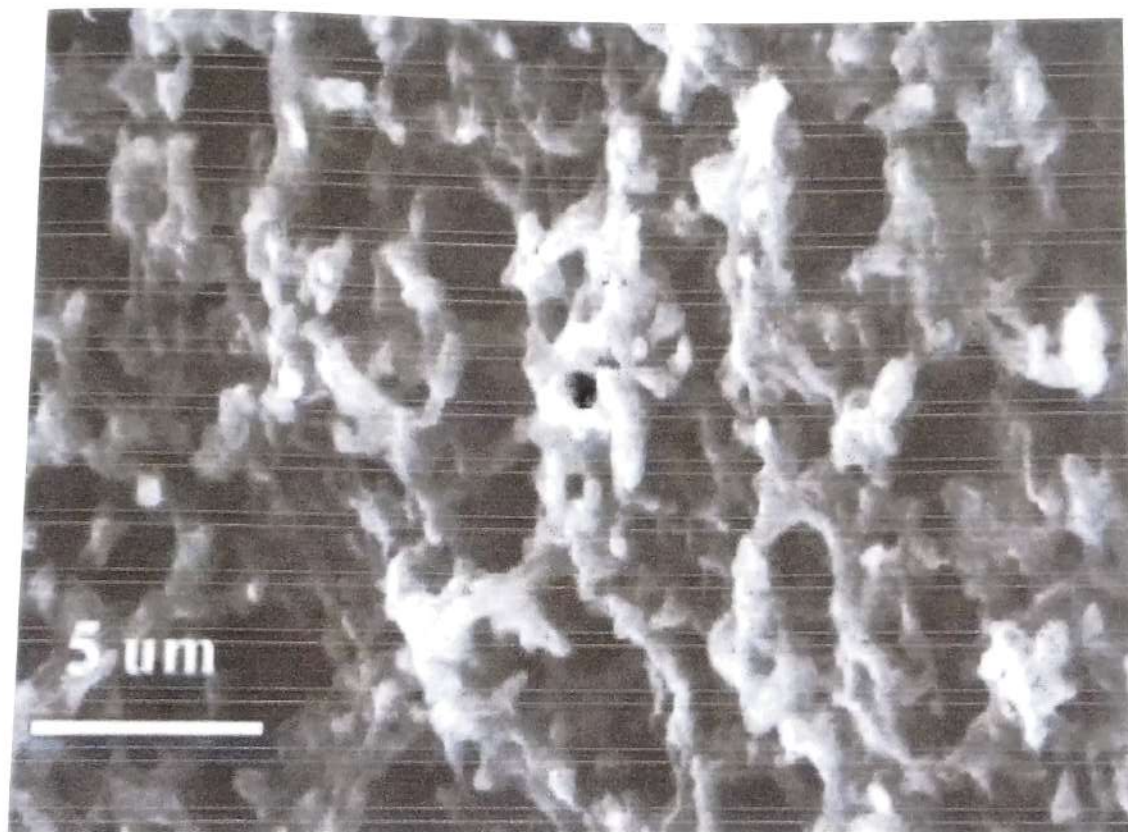


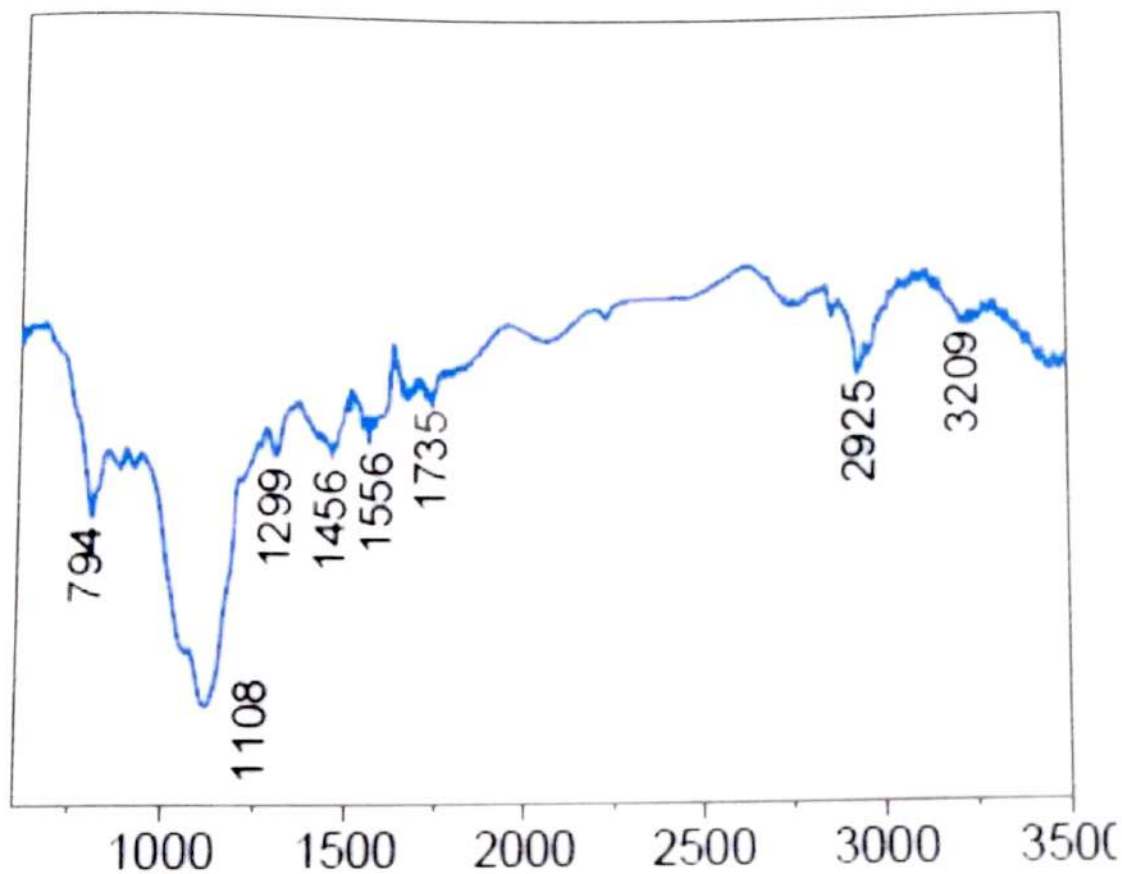
Fig.
SEM

images of the PANI

2. FTIR of Nano particles of PANI:

The characteristic bands in the IR spectrum of PANI occur at 3209, 2925, 1556, 1456, 1299, 1108, and 794 cm^{-1} . The band at 3209 cm^{-1} represents the N-H stretching modes. The one at 2925 cm^{-1} could be attributed to the C-N stretching of secondary aromatic amine (-N-

benzenoid-N-), and the ones at 1556 and 1456 cm^{-1} are attributed to C=N and C=C stretching



modes for the quinoid and benzenoid rings, respectively

Fig. FTIR spectra of Nano particles of PANI

3. TGA of Nano particles of PANI

Thermal gravimetric analysis measurements were done from room temperature to 1000 $^{\circ}\text{C}$ at a heating rate of 10 $^{\circ}\text{C}/\text{min}$ under N_2 atmosphere. In Figures show the amount of weight loss with respect to temperature in synthesized pure polyaniline.

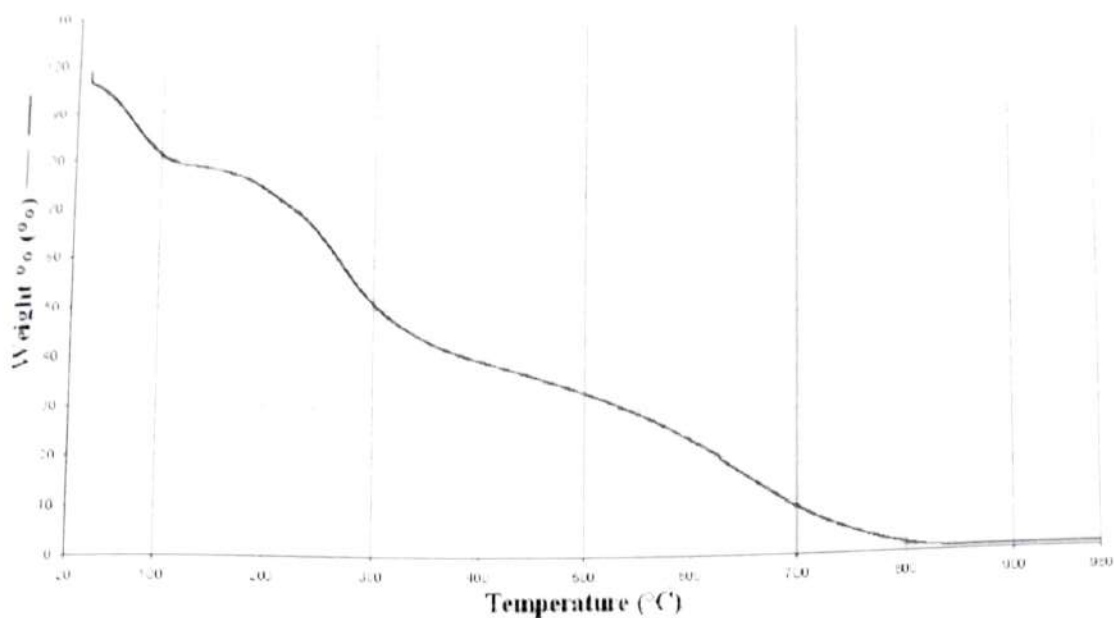


Fig. TGA spectra of Nano particles of PANI

Characterizations of PANI-TiO₂ nanocomposites:

The scanning electron microscopic images were recorded and the transmission electron microscopic studies were performed. FT-IR measurements were carried out on a FT-IR spectrometer in the form of dried samples by using KBr pellets. Solid-state UV-Vis spectra were recorded on a Shimadzu 2100 spectrophotometer in the range of 200-900 nm, and BaSO₄ was used as a reference. The cyclic voltammetric (CV) measurements were performed. Thermogravimetric analysis (TGA) was carried out at a heating rate of 10 °C min⁻¹ in air.

Fourier- transform infrared spectra:

FT-IR spectra of TiO₂ and PANI/TiO₂ were shown in Figure a and b. In addition to observed peaks due to TiO₂ in Figure a, the main characteristic bands of polyaniline were seen in Figure b. The band at 3450 cm⁻¹ is attributable to N-H stretching. The bands at 1577 and 1485 cm⁻¹ corresponded to quinoid and benzenoid structure of PANI, respectively. Also the band at

1310 cm^{-1} assigned to C-N stretching of a secondary aromatic amine. The peaks at 1035 and 1009 cm^{-1} belong to asymmetric and symmetric S=O stretching and this confirms the presence of SPS in the complex. Because titanium is a transition metal, it has intense tendency to form coordination compound with nitrogen atom in PANI macromolecule. This interaction may weaken the bond strengths of C=N, C=C and C-N in PANI macromolecule. These results confirm to the presence of PANI and SPS in nanocomposite.

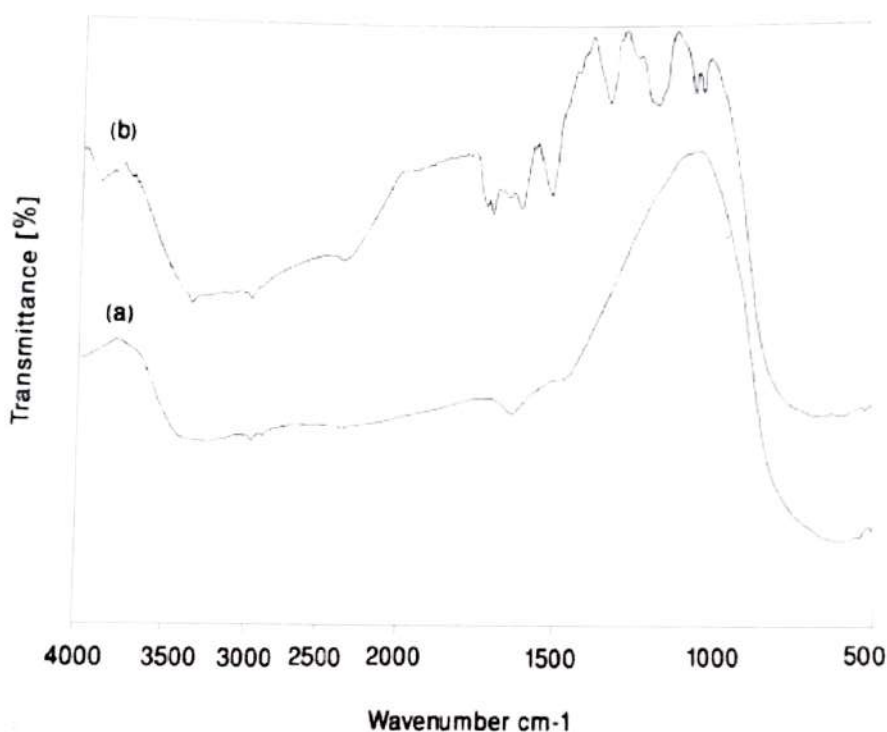


Figure . FT-IR spectra of a) TiO₂ and b) PANI/TiO₂ nanocomposite,

UV- Vis. Spectroscopy:

The UV-Vis spectrum of the PANI doped with SPS and reflectance spectrum of PANI/TiO₂ nanocomposite is shown in Figure a and b. In Figure a, the three characteristic bands of doped PANI with SPS appear at about 365, 480 and over 820 nm. From Figure 4(b), it can be seen that the prepared nanocomposite can strongly absorb the UV and visible light. The hybrid samples present characteristic bands of PANI at about 380, 460 and over 820 nm. Moreover, the peak at over 480 nm in PANI doped with SPS is obviously shifted to 460 nm in nanocomposite. It

indicates that encapsulation of TiO₂ NPs has the effect on doping of conducting polyaniline. This shift shows shortening in the conjugation length that reported previously or may be the coordinating complex formation between TiO₂ NPs and PANI chains.

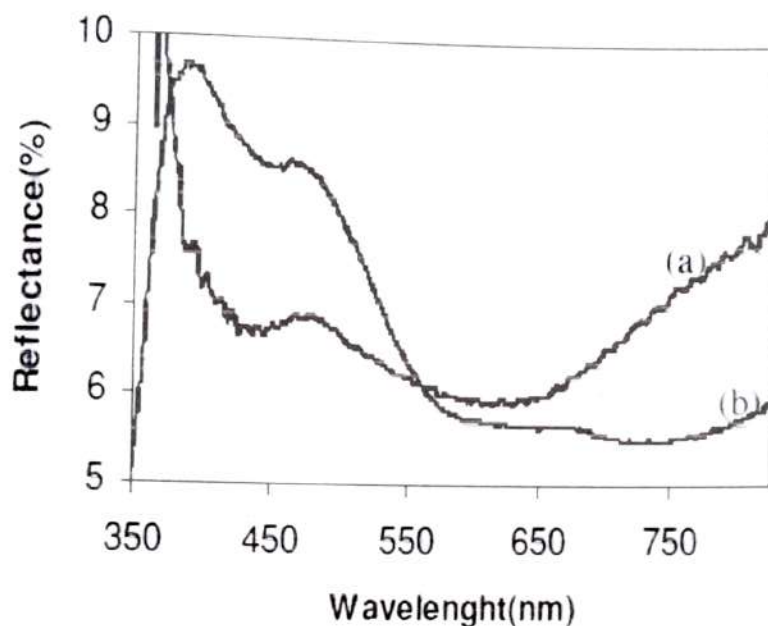


Figure: UV-Vis spectra of (a) PANI doped with SPS and (b) PANI/TiO₂ NPs composite complex.

Morphological characterization:

Morphological studies were done with SEM and TEM, which confirm the formation of nanocomposite. Scanning electron micrographs of TiO₂ nanoparticles are shown in Figure a and PANI/TiO₂ nanocomposite in Figure b. Comparing these images showed that the growing of PANI on TiO₂ NPs surfaces. In accordance to our studies, aniline in the presence of TiO₂ NPs, dimension increased almost 5-7 nm. As shown in SEM and TEM images, polyaniline layers on the TiO₂ NPs surface attached together and generated the porous PANI/TiO₂ nanocomposite. In fact, such structure has been created from the TiO₂ NPs presence in the course of enzymatic

polymerization process. This is a result of polymer growth on the surface of nanoparticles. In addition, it is easy to control the composite structure using various types and shapes of metal oxide nanomaterials. Since composites made from metal oxide nanomaterials exhibit essential stability (owing to metal oxide nanomaterial structures) and polymer film growth is efficiently stable, this approach can be successfully employed for applied purposes.

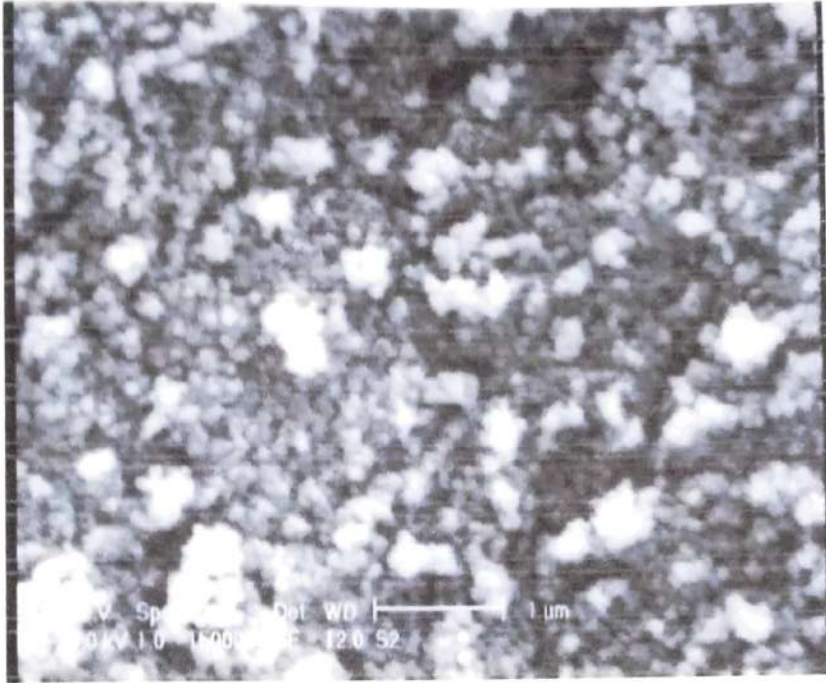


Figure a. SEM images of TiO₂ NPs

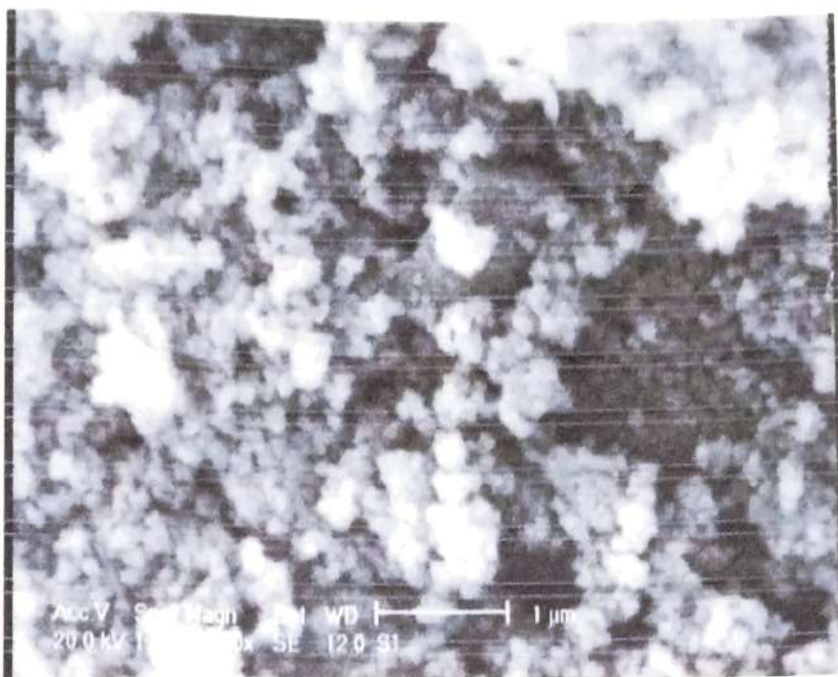


Figure b. SEM images PANI/TiO₂ NPs composite.

Thermogravimetric analysis (TGA):

The thermal behavior of the TiO₂ NPs and PANI/TiO₂ NPs composite samples were investigated by TGA, and the results are shown in Figure 1. In this Figure, curve (a) shows that TiO₂ NPs is very stable in air and no decomposition takes place in the range of 20-800 °C. The thermogravimetric curve of PANI/TiO₂ is shown in Figure 1(b). The results show that the trend of PANI/TiO₂ NPs composite degradation is similar to PANI, but the thermal stability of synthesized nanocomposite is lower than chemically synthesized PANI probably due to some chain defect. The first weight loss observed at 80 °C was essentially due to desorption of water absorbed on the doped polymer. This curve also indicates that there is a sharp weight loss near 430 °C and continues until 660 °C, which is attributed to degradation of skeletal polyaniline chain structure. The temperature of thermal decomposition of polyaniline in PANI/TiO₂ NPs composite is about 430 °C which is lower than pure polyaniline at 480 °C. These results indicate that a strong interaction exist at the interface of PANI and TiO₂ NPs which probably weakens

the interaction of inter-chains in PANI, that leads to thermal degradation of polyaniline. TGA analysis indicates that the nanocomposite contains 25% conducting PANI by mass.

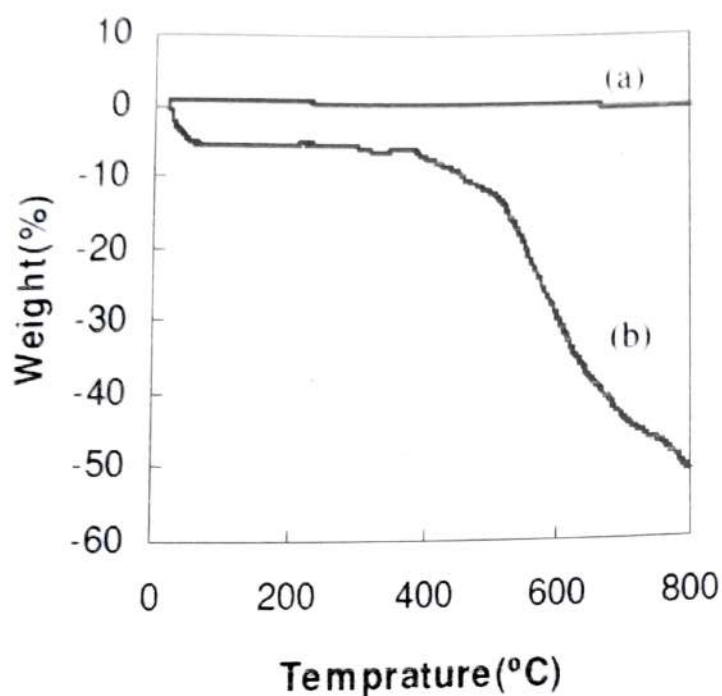


Figure 1. Thermogravimetric curves of TiO₂ NPs (curve (a)) and PANI/TiO₂ NPs composite (curve(b)).

3. Synthesis of Nano particles of Polypyrrole (PPy) Doped With DBSA In HCl Medium

Polymerization was carried out by the chemical oxidation of pyrrole in the presence of SDS and APS in an aqueous HCl (1N) medium, both played the role as dopant and oxidant respectively. SDS (0.1611 mol) was dissolved in 111 mL of HCl in a four-neck round bottom reaction flask under mechanical stirring in ice bath (0 – 5 °C) for 2 hours. Pyrrole was stirred in 10 mL of HCl for 30 minutes. The solution was then added drop-wised into the SDS solution with vigorous stirring for 3 hours. The dispersion was stirred in an ice bath maintained at 0 – 5 °C. A solution of APS (0.1933 mol, cooled prior to use) in 120 mL HCl was latter added drop-wised for 2 hours into the solution to initiate the aniline polymerization. The temperature of the solution was kept between 0 – 5 °C under vigorous stirring until the addition of APS solution was completed. The reaction was later carried out for 24 hours at room temperature with stirring.

After termination of polymerization process, the precipitate obtained was filtered. The product was washed successively by methanol followed by distilled water. The synthesized Ppy was obtained as finely dispersed particles.

Preparation of PP/PPy nanocomposites

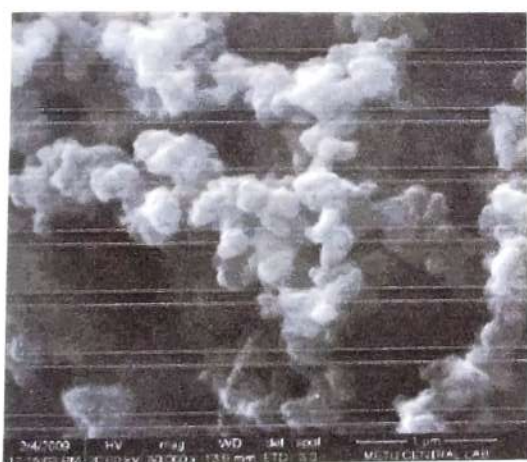
Preparation of mixed and moulded composites

PP/PPy nanocomposites were prepared by melt mixing of pure PP with PPy at 75 rpm for 10 minutes at 210°C. The composition of nanocomposites varied between 1-20% PPy by weight. In order to provide a regular shape, the nanocomposites were pressed in a mould for 5 minutes at 210°C followed by fast cooling. The identical procedure is employed with addition of 2% by weight dispersant (SDS) during mixing process of pure PP with PPy.

Characterization of Nano particals of PPy

1. Scanning electron microscopy (SEM) of Nano particals of PPy:

Scanning electron microscopy was performed in order to investigate the dimensions and the morphology of polypyrrole nanoparticles. The scanning electron micrographs of polypyrrole nanoparticles are presented in Figure 3.2. The SEM micrographs of polypyrrole exhibited globular, nanometer-sized particles. The polypyrrole nanoparticles are observed to have a distribution of dimensions between 50–150 nm.



(a)



(b)

Figure 3.2 SEM micrographs of PPy nanoparticles at magnifications of (a) 80000, (b) 300000.

The SEM results confirm that microemulsion polymerization system was successful in the synthesis of nanodimensional polypyrrole particles. The SEM results proves that the

microemulsion polymerization system provided similar dimensions of PPy nanoparticles with previous studies where 50-100 nm and 100-200 nm polypyrrole nanoparticles were reported [29,32].

2. FTIR of Nano particals of PPy:

Figure shows the FTIR spectra of PPy powder. The peaks at 811 cm^{-1} , 920 cm^{-1} are attributed to C-H wagging [17,18]. The characteristic peaks at 1558.4 cm^{-1} and 1487 cm^{-1} correspond to the C=C stretching, whereas peaks at 1685.7 cm^{-1} and 1315.4 cm^{-1} represent to respectively, C=N and C-N bonds [19]. The occurrence of small peaks at 3522 cm^{-1} is assigned to presence of N-H stretching vibrations. The peaks observed in the present work match well with the ones available in the literature [18,19] confirming the formation of Polypyrrole.

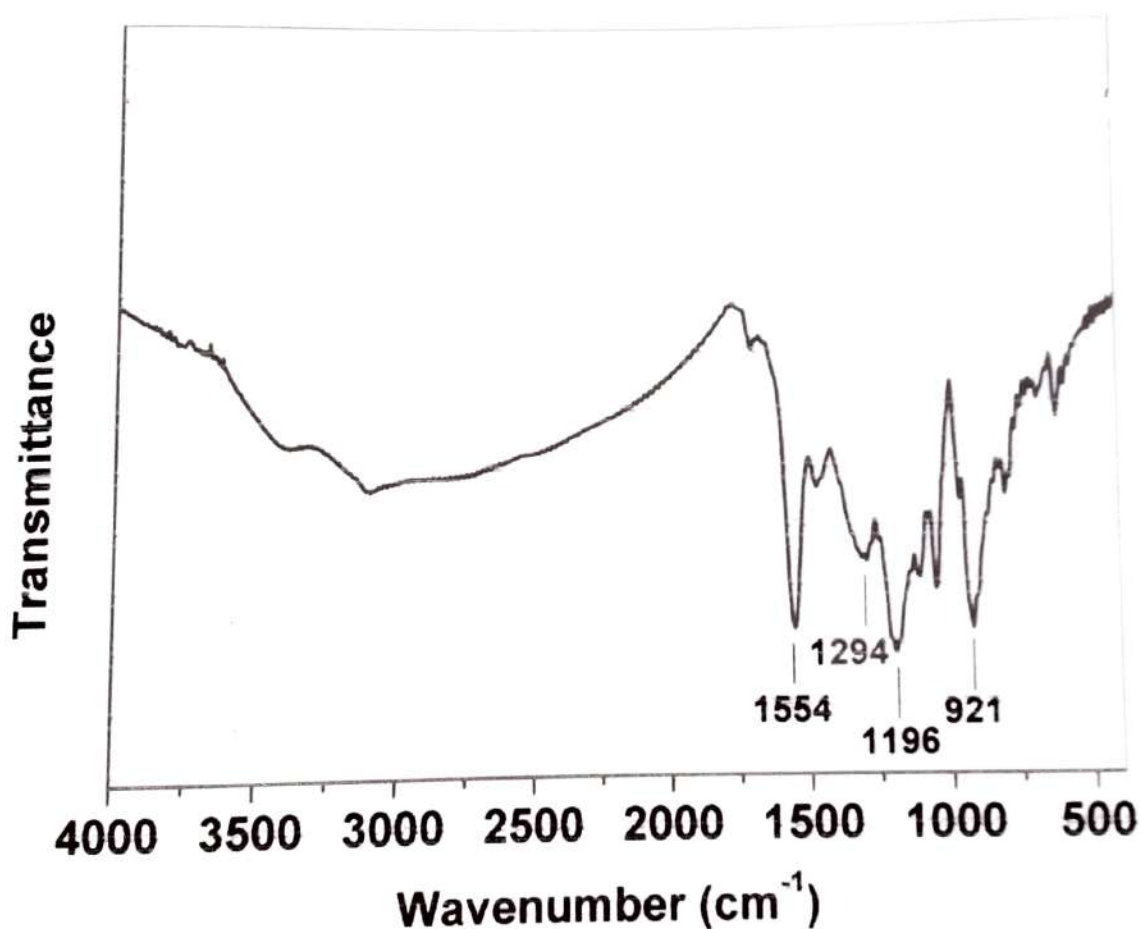


Fig. FTIR spectra of Nano particals of PPy

Characterization of PP/PPy nanocomposites

3.4.1 Tensile Tests

In this study, mechanical properties of PP/PPy nanocomposites were investigated by tensile tests. The effect of loading different amounts of polypyrrole nanoparticles into thermoplastic polypropylene matrix and the changes in mechanical properties produced by incorporation of polypyrrole nanoparticles were examined. In order to understand the effect of using sodium dodecylsulphate as dispersant in PP/PPy nanocomposites, identical tests were performed also for the nanocomposites prepared with dispersant. A stress-strain curve is known to provide information about both linear elastic properties and mechanical properties related to plastic deformation of a material. In order to specify a material as ductile or brittle, the response of the material to applied stress is investigated. The area under stress-strain curve corresponds to the energy required to break the material. As it is clearly seen in Figure 3.3, pure PP is very ductile at a test rate of 5 cm/min and the area under the curve is very large indicating the great energy

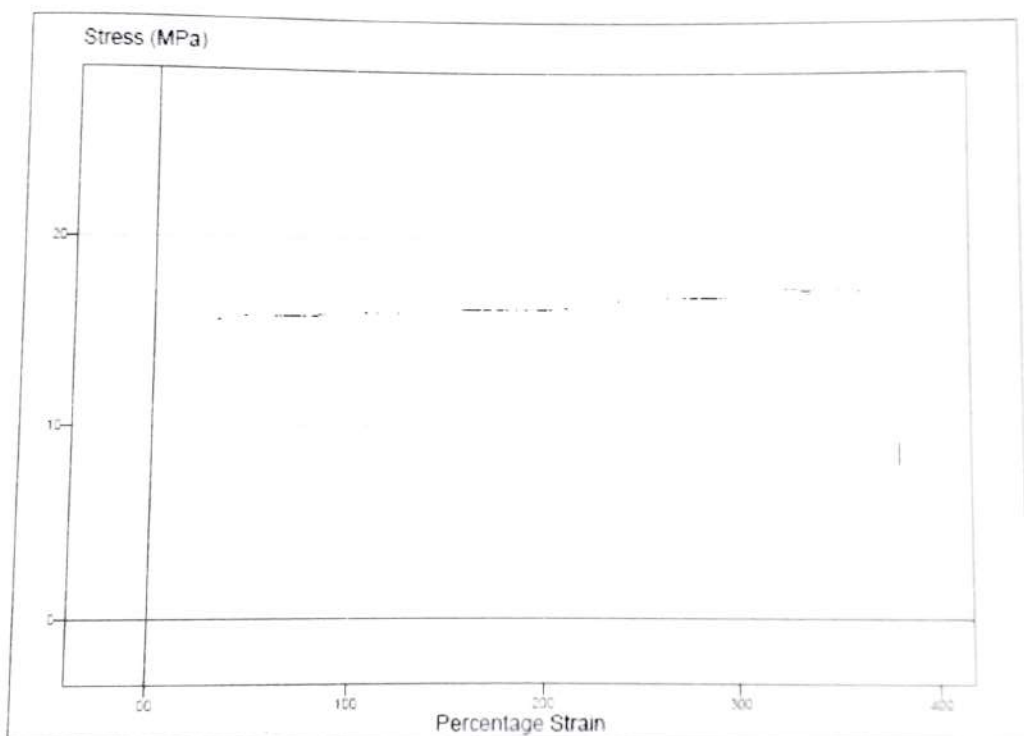


Figure 3.3 Stress vs strain curve of pure PP.

required to break the material. The Young's modulus, tensile strength and percentage strain at break values of pure polypropylene are 430 MPa, 27.8 MPa and %424 respectively. mechanical properties that are produced by loading different amounts of polypyrrole nanoparticles can be well understood from stress-strain curves of PP/PPy nanocomposites which are illustrated in Figure 3.4 through 3.8. As it is clearly observed in stress-strain curves of nanocomposites, addition of polypyrrole nanoparticles makes polypropylene matrix very brittle. In fact, addition of even the smallest amount of polypyrrole which is 1% causes a dramatic decrease in the energy required to break it. The Young's modulus, tensile strength and percentage strain at break values for PP/PPy nanocomposites are illustrated in Table 3.1. The change in percentage strain at break, tensile strength and Young's modulus with increasing amount polypyrrole nanoparticles are shown in Figure 3.9 through Figure 3.11. As it is clearly seen in Figure 3.9, addition of 1% PPy to PP matrix causes a dramatic decrease in percentage strain at break value of pure PP. As the amount of PPy nanoparticles in PP increases, the percentage strain of the nanocomposite decreases reaching its lowest value in PP/20%PPy nanocomposite (Figure 3.8). The reason for this is the fact that incorporation of PPy nanoparticles into pure PP causes disruption of polymer matrix. Due to the relatively weak interaction of PPy nanoparticles with PP, addition of even the smallest amount of PPy nanoparticles causes a great decrease in percentage strain at break value of pure PP. Since incorporation of PPy nanoparticles prevents elongation of ductile PP matrix, the decrease in percentage strain values is an expected result. The increase in Young's modulus and tensile strength values show that addition of PPy nanoparticles in PP enhanced the strength and the stiffness of the nanocomposites. The greatest change for both properties was observed in PP/1%PPy nanocomposite. As it is seen in Figure 3.10 and Figure 3.11, incorporation of 1% PPy into PP matrix increased the tensile strength and Young's modulus of pure PP considerably. Increasing amount of PPy nanoparticles in PP matrix caused gradual increase in both tensile strength and Young's modulus of nanocomposites until addition of 10% PPy nanoparticles. Further addition of PPy nanoparticles slightly change the tensile strength and Young's modulus.

Thermal Gravimetric Analysis

The thermal stability of nanocomposites was studied by Thermal Gravimetric Analysis. In order to investigate the effect of dispersant, identical test was employed also for nanocomposites

prepared with dispersant. Figure 3.22 shows the thermal decomposition of pure PP, PPy, PP/10%PPy and PP/20%PPy nanocomposites prepared without dispersant. From derivation of TGA curves, the maximum decomposition temperatures were estimated and summarized in Table 3.5.

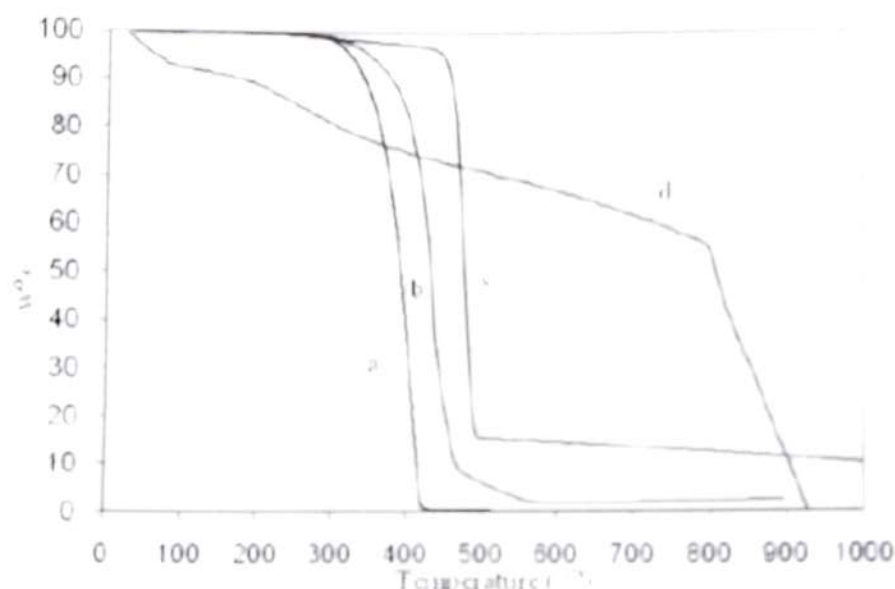


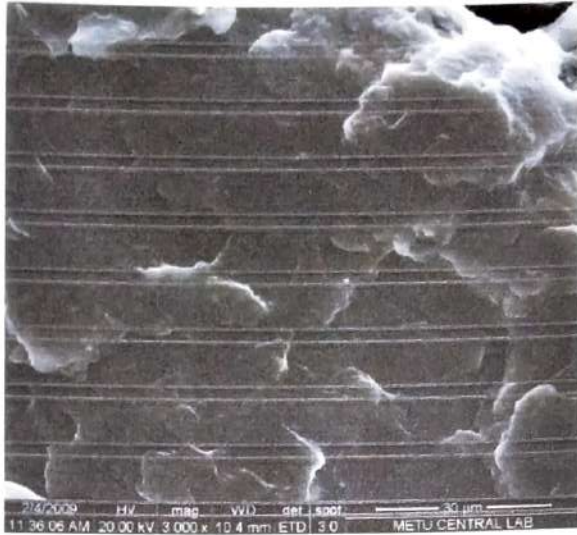
Figure 3.22 TGA plots of (a) pure PP, (b) PP/10%PPy, (c) PP/20%PPy nanocomposites prepared without dispersant, (d) PPy.

Scanning Electron Microscopy of PP/PPy Nanocomposites

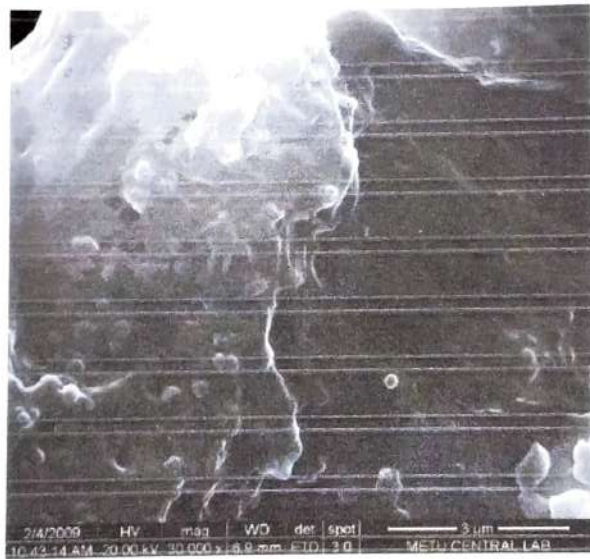
The fracture surfaces of nanocomposites were examined by scanning electron microscope. The SEM micrographs of PP/PPy nanocomposites prepared without dispersant are shown in Figure 3.24 through Figure 3.27. Figure 3.24 shows the SEM micrographs of PP/1%PPy nanocomposite prepared without dispersant. In the micrograph at magnification of 30000, PPy is observed as particles incorporated into PP matrix. The micrographs exhibit presence of 150–300 nm clusters of polypyrrole nanoparticles embedded into polypropylene matrix.

Figure 3.25 shows SEM micrographs of PP/5%PPy nanocomposite at magnifications of 30000 and 80000. Both micrographs exhibit presence of globular polypyrrole nanoparticles with

relatively large dimensions. The dimensions of polypyrrole clusters which are about 160–250 nm are clearly observed in the micrograph with 80000 magnification. The reason for formation of clusters can be explained by agglomeration of PPy nanoparticles due to poor dispersion in PP matrix. The fracture surface of PP/10%PPy nanocomposite is shown in Figure 3.26. Unlike PP/1%PPy and 5% nanocomposites, the fracture surface of PP/10%PPy nanocomposite involves less nanoparticle images which indicates that large amount of PPy nanoparticles were embedded in PP matrix. Figure 3.27 exhibits the fracture surface of PP/20%PPy nanocomposites at magnifications of 3000 and 30000 respectively. The micrograph at 30000 magnification clearly shows clusters of polypyrrole nanoparticles on the fracture surface of PP/20%PPy nanocomposite. This shows the fact that as the amount of PPy reaches 20%, by weight, PPy can not be found in the form of nanoparticles and formation of clusters can no longer be prevented.

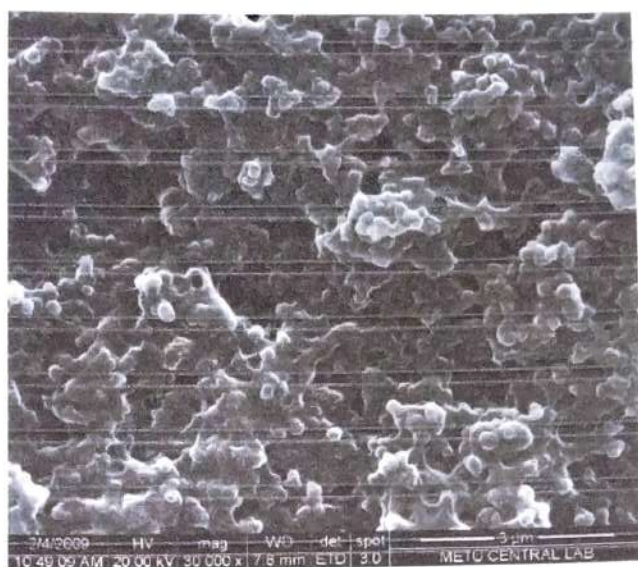


(a)

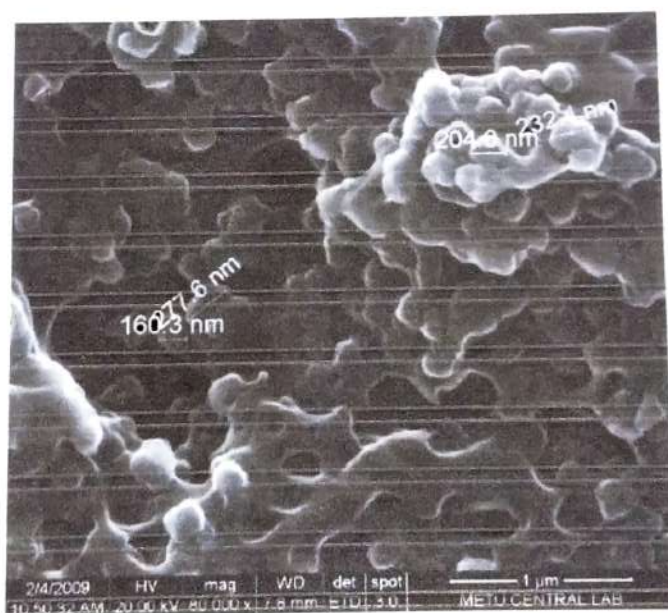


(b)

Figure 3.24 Fracture surface of PP/1%PPy nanocomposite without dispersant at magnification of (a) 3000, (b) 30000.

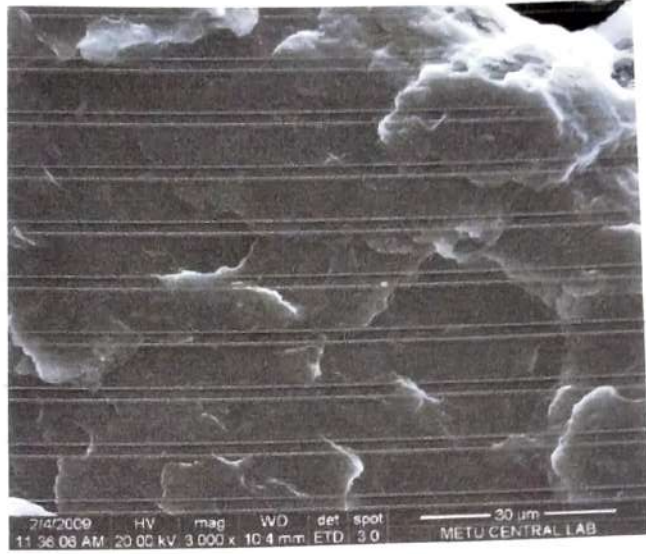


(a)

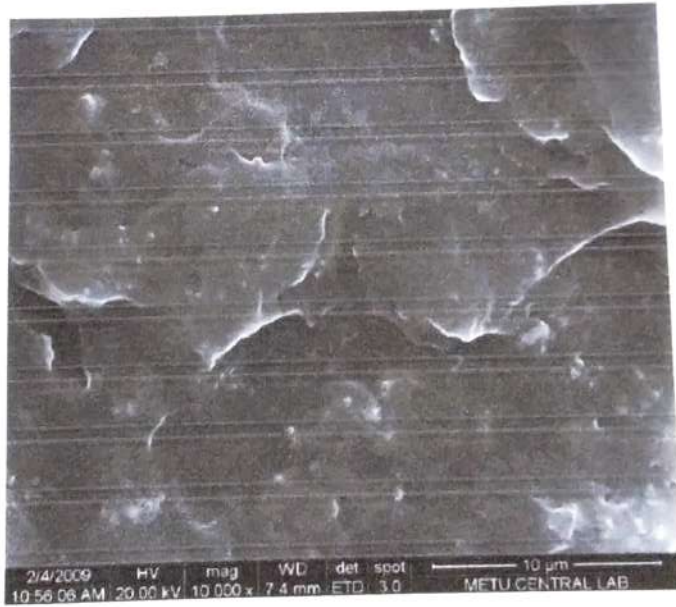


(b)

Figure 3.25 Fracture surface of PP 5%PPy without dispersant at magnification of (a) 30000. (b) 80000.

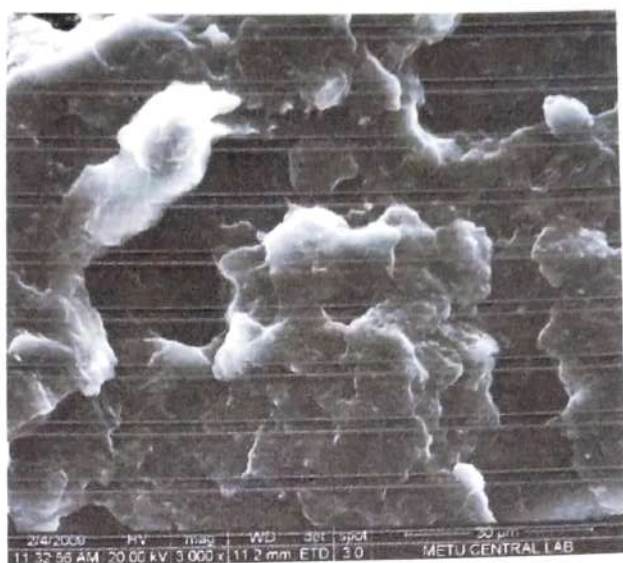


(a)

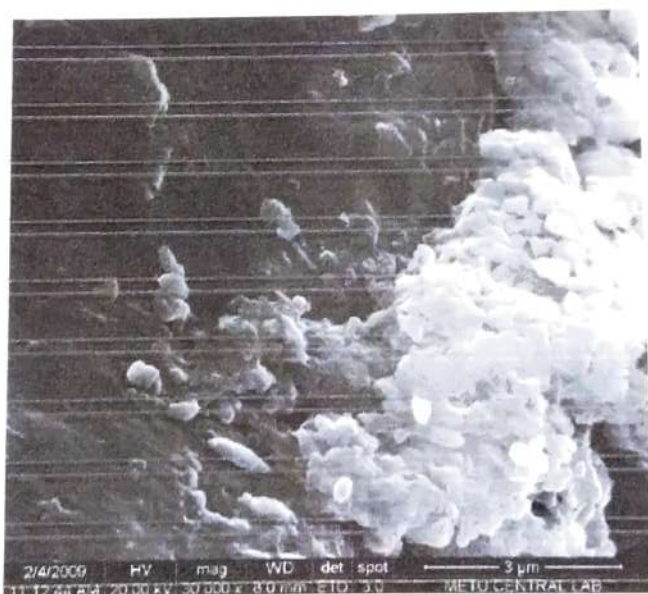


(b)

Figure 3.26 Fracture surface of PP 10% PPy without dispersant at magnification of (a) 3000, (b) 10000.



(a)



(b)

Figure 3.27 Fracture surface of PP 20% PPy without dispersant at magnification of (a) 3000. (b) 30000.

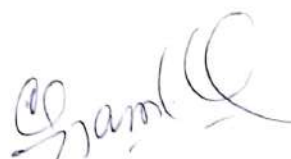
The fracture surfaces of PP/PPy prepared with dispersant are shown in Figure 3.28 through Figure 3.31. The SEM micrographs of PP/1%PPy nanocomposite prepared with dispersant which is exhibited in Figure 3.28 clearly shows the presence of regularly dispersed globular polypyrrole particles having nanodimensions. The enhancement in dispersion and decrease in nanoparticle dimension can be explained by the effect of dispersant used. Figure 3.29 shows SEM micrographs of PP/5%PPy nanocomposite prepared with dispersant at magnifications of 30000 and 80000 respectively. Similar to PP/1%PPy nanocomposite prepared with dispersant, globular polypyrrole nanoparticles having dimensions about 60–100 nm is well observed in the micrograph with 80000 magnification. The SEM micrographs of PP/10%PPy nanocomposite prepared with dispersant which are exhibited in Figure 3.30 show presence of polypyrrole both in nanoparticle and cluster form embedded in PP matrix. This situation shows that as the amount of polypyrrole increases, the dispersant becomes insufficient to prevent formation of polypyrrole clusters. Figure 3.31 exhibits the fracture surface of PP/20%PPy nanocomposite prepared with dispersant at magnifications of 3000 and 30000 respectively. Similar to previous case, the fracture surface of PP/20%PPy nanocomposite prepared with dispersant exhibits presence of polypyrrole both in nanoparticle and cluster form. Since 20% is the highest amount of polypyrrole used in nanocomposites, this situation is an expected result.

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(Shri. I. B. Chaudhari)
Principal Investigator


1. UTILIZATION CERTIFICATE FOR TOTAL / UTILIZED GRANT

It is certified that the grant of Rs. 3,12,500/- (Rupees Three lakh Twelve Thousand Five Hundred only) by University Grants Commission vide their letter No. F-47-673/13 (WRG) Dated: 27 March 2014 towards the Minor Research Project awarded to Shri. Ishwar Babubhai Chaudhari, entitled "Green synthesis, characterization and application of Polyaniiline copolymers/ composite blends as anti-Corrosive coatings" has been fully utilized for the purpose for which it has been sanctioned and in accordance with the prescribed terms and conditions laid down by Commission. The amount received against the total sanctioned amount is Rs. 3,12,500/- (Rupees Three lakh Twelve Thousand Five Hundred only)

If, as a result of check or audit objection, some irregularity is noticed at a later stage, action will be taken to refund or regularize the objected amount.

Total actual expenditure incurred for this project is Rs. 3,14,754/- (Rupees Three lakh Fourteen Thousand seven Hundred fifty four only)

For P.D. DALAL & Co.
Chartered Accountants


(Avinash R. Chundryal)
Partner

ML.No.147861



(Prof. Dr. R. S. Patil)
Principal

Chartered Accountant with seal
Regd. No. of C.A

13 MAR 2020


(Shri. I. B. Chaudhari)
Principal Investigator

S.I.P. Arts, Sci., P. Science &
S.T.K.V.S. Comm. College
SHAHADA



UDIN. 20147861AAAA8V2691

2. STATEMENT OF EXPENDITURE

1	File No.	:	47-673/13 (WRO)
2	Name of Principal Investigator	:	Ishwar Babubhai Chaudhari
3	Name of College	:	Shri S.I. Patil Arts, G. B. Patel Science and S. T. K. V. S. Commerce College, Shahada, District – Nandurbar
4	Title of the Research Project	:	“Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti- Corrosive coatings”
5	Date of starting the project	:	1 st June 2014
6	Date of Completion of Project	:	1 st Dec. 2016

Sr. No.	Item	Sanctioned Amount(Rs.)	Received Amount (Rs.)	Actual Expenditure (Rs.)
1	Books & Journals	25000/-	25000/-	25217/-
2	Equipment	210000/-	210000/-	210822/-
3	Contingency	17500/-	17500/-	17521/-
4	Travel/ Field Work	7500/-	7500/-	8125/-
5	Hiring Services	12500/-	12500/-	13000/-
6	Chemicals & Glassware	40000/-	40000/-	40069/-
Total			3,12,500/-	3,14,754/-

If as a result of check or audit objection some irregularly is noticed at later date, action will be taken to refund, adjust or regularize the objected amounts.

F.D. DALAL & Co.
Chartered Accountants

(Avinash. P. Chundiyal)
Partner
M.No.147261



(Prof. Dr. R. S. Patil)
Principal
Principal
S.I.P.Arts, G.B.P.Science &
S.T.K.V.S.Comm.College
SHAHADA

Chartered Accountant with seal
Regd. No. of C.A



(Shri. I. B. Chaudhari)
Principal Investigator



UDIN-20147861AAAABV2691

3. PROJECT COMPLETION REPORT (PCR)

Certified that the grant of Minor Research Project entitled "**Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti-Corrosive coatings**" awarded to Shri. Ishwar Babubhar Chaudhari has been successfully completed and all completion documents have been submitted to UGC-WRO, Pune.



(Prof. Dr. R. S. Patil)

Principal

PRINCIPAL

P.S.G.V.P. M's, Arts, Science &
Commerce College, SMAHADA
Dist. Nandurbar (Pin-425409)



(Shri. I. B. Chaudhari)
Principal Investigator

4. ASSETS CERTIFICATE

It is certified that the following equipment purchased from MRP grant have been handed over to the college and have been duly entered in the Stock Register maintained by the college.

Sr. No.	Name of the Equipment
1	RQT-124A/D Stirrer with Motor (Remi)
2	Calomel Electrode
3	Vacuum Desiccator with Neck
4	ITO Coated Glass
5	Membrane Fitters Packet Milipore 0.45 UM
6	OH Electrical Stirrer Remi RO 126/D with Digital Display
7	Platinum wire 1 MM x 2 CM
8	Silver Wire
9	Ultrasonictor Processer Variable Frequency
10	Rotary Vacuum Pump oil Trason Model 7040
11	Glass Stirring Rod Teflon Blende 6mm
12	Stirring Guide for Above Rod Teflon
13	Four Probe Method Model DFP - RM (SES)

For P.D. DALAL & Co.
Chartered Accountants

(Against P. S. Jindiyal)

11/03/2020



(Prof. Dr. R. S. Patil)

Principal

Principal

S.I.P. Arts, G.B.P. Science &
S.T.K.V.S. Comm. College
SHAHADA

UDIN: 20147861AAAABV2691

13 MAR 2020



(Shri. I. B. Chaudhari)

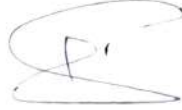
Principal Investigator

5. ACCESSION CERTIFICATE

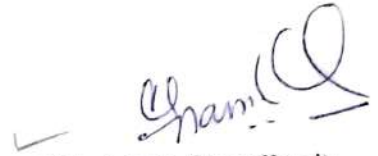
It is certified that the Book purchased from Minor Research Project grant are handed over to the college central / departmental library. Their Accession number is From 421 / R-45 to 424 / R-48.



(Prof. Dr. R. S. Patil)
Principal
Principal
S.I.P.Arts,G.B.P.Science &
S.T.K.V.S.Comm.College
SHAHADA



Shri. B. S. Patil
Librarian
LIBRARIAN
P. S. G. V. P. Mandal's
Arts, Sci. Comm. College
SHAHADA (Dist. Chandurbar)



(Shri. I. B. Chaudhari)
Principal Investigator

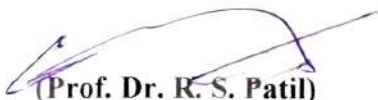
6. STATEMENT OF EXPENDITURE INCURRED ON FIELD WORK

Name of Principal Investigator: **Ishwar Babubhai Chaudhari**

Title of the Project: **"Green synthesis, characterization and application of Polyaniline copolymers/ composite blends as anti- Corrosive coatings"**

Name of the Place visited	Duration of the Visit		Mode of Journey	Expenditure Incurred (Rs.)
	From	To		
Pune	05.05.2015	08.05.2015	Taxi	8125/-
Total				8125/-

Certified that the above expenditure is in accordance with the prescribed UGC norms from Minor Research Projects.



(Prof. Dr. R. S. Patil)

Principal

PRINCIPAL

P.S.G.V.P.'s, Arts, Science &
Commerce College, SMAHADA
Dist. Nandurbar (Pin-425409)



(Shri. I. B. Chaudhari)
Principal Investigator