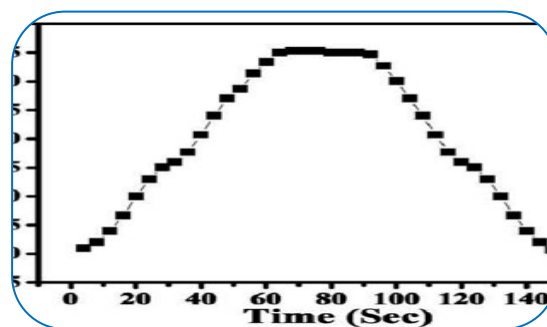




“SYNTHESIS, CHARACTERIZATION OF POLYANILINE DOPED BY SILVER AND ITS APPLICATION AS SENSOR FOR AMMONIA GAS”

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ABSTRACT :

PANI -Ag nanocomposite was successfully synthesized by simple wet chemical route by colloidal chemistry. PANI -Ag nanocomposite exhibit the significant blue shift. PANI -Ag nanocomposite is well crystalline with average crystallite size. For preparation of Ag nanoparticles two stabilizing agents are used sodium dodecyl sulphate (SDS) & Citrate of sodium used. Ag_2NO_3 used as metal salt precursor & stabilizing agent Hydrazine hydrate solution used in conc. ranging & citrate of sodium solution used as reducing agent. Citrate of sodium also used as stabilizing agent at room temperature. The transparent colourless solution was converted to the characteristics pale yellow and pale red colour when citrate of sodium was used as stabilizing.

KEYWORDS : Monomer, Polymer, Polymerization, Classification of polymer, Condensation or step polymerization mechanism, Structural requirement, Synthesis of Polyaniline, Synthesis of Ag nano powder.

INTRODUCTION:

1.1. Basic Information:

- There are probably even more elements in the Sun that are present in such a small amount that our instruments can't detect them.
- Here is the 10 most common elements in the Sun.
- Life on earth has started with the information of polymers, proteins, cellulose, polyphosphates; DNA, etc. are the natural polymers.
- Man started making synthetic polymers in the 20th century and the commercially the products are in use from later half of the 20th century.
- The synthetic polymers have gained today such importance that the modern lifestyle cannot be imagined without them.
- The rubbers are also such type of molecules but rubber possesses a special property of elasticity.

The synthetic polymers find uses as the substitute or alternative material for:

1. Metals
2. Wood
3. Gum
4. Glass
5. Ceramics

- The most important of the synthetic polymers used on tonnage scales are polyethylene. Polypropylene, polystyrene, polyvinyl chloride.

- The synthetic polymers are made from petrochemicals. Some polymers can be derived on modification of natural polymers.

1.1.1: Monomer:

- Monomer is the simple chemical substance of low molecularweight which can be converted into a polymer and the molecule of monomer has at least easily reacting positions.
- With help of these reactive positions, the joining of large number of monomer molecules can be done to get a polymer. The monermolecules has act as the building blocks of polymers.
- A monomer molecule has the easily reacting position in the form of either functional group or in the form of C=C .
- The functional groups in the monomer organic molecules can be like-OH,- COOH,-NH₂,-CL. Cyclic amide group, cyclic acid anhydride group, etc.
- Hydrogen atoms at Ortho and Para position on the activated aromatic rings are also easy to substitute during polymerization.

1.1.2: Polymer

- A Polymer material is composed of very larger molecules or macro molecules.
- A Polymer is defined as the substance very high molecular weight is mode by Joining the large no sample molecules therefore the polymer molecules have certain structural unit reporting large no. times.

1.1.3: Polymerization

- The chemical process in which a large number of monomer molecules get joined to formed the polymer molecules, is known as polymerization.
- A large number of ethylene molecules (monomer) get jointed by chemical bonds to formed polyethylene.
- The number of monomer molecules that get jointed to formed polymer molecules is generally greater than 100 and may be up to many thousands.

1.2: Classification of Polymers

Polymers can be classified in various ways; e.g. On the basis of origin (natural 'synthetic/semi synthetic polymers), on the basis of chemical nature (organic/inorganic Polymers) structure of polymer molecules (liner, branched, cross linked), etc.

Following ways of classification here;

- (1) On the basis of polymerization reactions.
- (2) On the basis of numbers of monomers.
- (3) On the basis of effect of heat on polymers (thermal behaviors).
- 4)On the basis of structure of polymer molecules.

1.2.1. Classification On the basis of polymerization reactions:

On the basis of type of polymerization reaction, polymers are classified as

- (a) Addition or chain polymers
- (b) Condensation or Step polymers

(a) Addition or chain polymers:

- The polymers obtained by Addition or chain polymers action of monomer, are the addition or chain polymers. During the addition reaction, pi-bond in the monomer is utilized for polymerization and there is no by-product formation.
- Addition or chain reaction forms the polymer having formula exact multiple of monomer formula.

- All vinyl monomers ($\text{CH}_2=\text{CH-R}$) undergo the addition reaction during polymerization, in the presence of a catalyst or initiator. This type of reaction is fast and exothermic. e.g. PE, PVC, PMMA, PTEE, PVA, etc.

(b) Condensation or Step polymers:

- Monomers having functional groups undergo condensation reaction. A condensation reaction involves the joining of monomer molecules by reaction between the functional groups and there is formation of a by-product.
- The condensation or step polymers are formed by slow, progressive and stepwise joining of monomer molecules, with formation of a by-product.
- Polymers obtained by condensation reaction between monomer between monomer molecules, are the condensation or step polymers. E.g. polyester, polyamide (nylon), urea- formaldehyde resins, epoxies polymers, etc.

1.2.2: Classification On the basis of numbers of monomers:

On the basis of whether one monomer forms the polymer or more monomers form the polymer, the polymers are divided into two classes:

- a) Homo polymers b) Copolymers

(A) Homo polymers:

The polymers are obtained by polymers of the one Monomer. e.g. $-(\text{CH}_2-\text{CH}_2)_n-$ polythene obtained on monomer $\text{CH}_2=\text{CH}_2$.

(B) Copolymers:

This polymer is obtained by polymerization of two or more monomers. The copolymer chain contains two or more types of repeating units. The copolymers can be further classified into four groups, on the basis of the pattern of repeating unit's arrangement in the chain.

These copolymers are again divided in four types; which are given below;

(a) Alternative copolymer:

The monomer molecules join alternatively to form the copolymer e.g. all monomer taken in equal moles for preparing the alternating copolymer

-A-B-A-B-A-B-A-B-A-B- (A and B monomers in copolymer chain)

A-B-C-A-B-C-A-B-C-A- (A, B and C monomer in copolymer chain)

(b) Random copolymers: The monomer molecules join a random manner to form the copolymer.

e.g -A-A-B-A-B-B-A-B-B-B-

The monomer are taken in different moles proportion and the reaction joins them in random manner

(c) Block copolymers:

Block copolymer chain contains the block wise joining of monomers e.g. -A-A-A-B-B-B-B-A-A-B

(d) Graft copolymers:

- Small branches (grafts) of one monomer attach to the main chain back-bone of other monomer to form the co polymer.
- The properties of copolymer depend upon structure of repeating units, relative amounts of monomers and the type of arrangement of the monomers in copolymer chain.
- Random and block copolymers are commercially more important.
- The copolymer possesses all the better properties of the individual polymers, in combination.

1.2.3. Classification on the basis of heat effect (Thermal behavior):

Depending upon the effect of heat on polymer, the polymers are divided in to following two types

- a) Thermo softening polymers (Thermoplastics)

b) Thermo setting polymers**A) Thermo softening polymers (Thermoplastics):**

- Those polymers which become soft on heating and hard on cooling, reversibly are known as thermo softening polymers. when these polymers become enough soft on heating, they can be molded with pressure/mold.
- These plastics are characterized by their linear structure. (They are generally produced from vinyl monomers by addition reaction) e.g. PVC, PE, PS, nylons, polyesters, etc. These polymers are softer, weak, and soluble.

B) Thermo setting polymers:

- The polymers which do not soften on heating are known as thermosetting polymers.
- They are made from resin is heated in a mold along with cross linking agent if necessary and catalyst to give the required shape.
- Once the thermosetting polymer obtained, it cannot be remolded. However, it can be cut sawn, drilled.
- These polymers have highly cross linked molecules, three dimensional and these polymers are very hard, brittle, tough, and insoluble. E.g. urea, formaldehyde plastics, Bakelite (Phenol- formaldehyde plastics), melamine formaldehyde plastics, alkyd resin, highly vulcanized rubbers, epoxy plastics.

1.2.4. Classification on the basis of structure:

On the basis of structure of polymers, they are classified as:

- A) Linear polymers
- B) Branched polymers
- C) Cross linked polymers.
- D) coiled polymers.

A) Linear polymers: When each monomer unit is joined to two other monomer units, the formed linear polymers.

-A-A-A-A-A-A-A-A-A-Linear homo polymer.

-A-B-A-B-A-B-A-B-A-B-Linear copolymer

B) Branched polymers:

- During the chain growth, by free radical mechanism, some side chains of considerable length may be formed, producing a branched polymer.
- The branched polymer can also be produced by maxing small amount of a bi functional monomer.
- The branched polymer molecules may be getting entangled in each other to form highly amorphous polymer. Generally branched polymers have low crystalline.
- The highly branched polymers are soft, weak, and waxy.

C) Cross linked polymers:

- When tri functional or higher functionality monomer are used in polymer making, a three dimensional network like polymer molecules are formed.
- It is also possible to join the neighboring linear chains to each other by a cross linking agent or through covalent bonds with some bridging atoms, to produce cross linked chains.
- A low degree of cross linking of rubber molecular chain can be done with a cross linking agent like sulphur to retain the rubber properties but to increase strength.
- High degree cross linking is present in phenol formaldehyde resins, alkyl resins etc. The high degree of cross linking makes the polymer thermosetting.

B) Coiled polymers:

- All synthetic rubbers and natural rubber have the long molecules of polymer in the form of spring.
- Such polymers are not only highly flexible but also elastic e.g. cis-polyisoprene (Natural rubber), SBR, silicone rubber, butyl rubber, etc.
- The spring like molecules can be stretched to form extended spring structure or can be compressed to form compact spring molecule.

1.3. Mechanism of polymerization:

There are two types of mechanism for formation of polymers from monomers

- A) Addition or chain mechanism of polymerization.
 B) Condensation or step mechanism of polymerization.

A) Addition or chain Mechanism of polymerization:

Polymerization of monomers with C=C (vinyl monomers) takes place by this mechanism. Sometimes other containing groups like, -CN, -N=C=O in the monomer may also have this mechanism.

The addition or chain polymerization has following features:

1. There is need of catalyst or initiators like free-radical/reactive cat ion/reactive anion/ co- ordination catalyst.
2. The reaction is highly exothermic and may cause hazards if cooling provision not made, during the polymer production.
3. Once the reaction begins with initiator, it proceeds very fast.
4. C=C in the polymer molecule formula is an exact multiple of monomer formula.
5. No by-product is obtained.
6. The mechanism involves initiation; propagation and termination steps Polymer molecule ends are not reactive or are dead.

Depending up on the nature of catalyst used, four chain mechanisms are as below,

- a) Free radical
- b) Anionic
- c) Cationic
- d) Co-ordination

a. Free radical chain mechanism:

Initiators

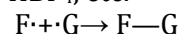
H₂O₂, benzoic peroxide, azobis-isobutyl-ronitrile, laurel peroxide, in suitable solvent.

This forms more or less branched polymer and attaching stereo irregular polymer. The initiator first forms a free radical.

1) Initiation: Free radical chain mechanism in polymerization.

2) Propagation: Once the reaction is initiated, it proceeds further very rapidly monomer molecules. Simultaneously a large number of chains grow further or propagate; by use of pi- bond in monomer molecule.

3) Termination: After the polymerization to certain extent taken place, the growing chain ends are made dead by either disproportion or using a chain transfer agent. Termination Catalyst: acid like H₂SO₄, HBP₄, etc.



Consider the general cationic chain mechanism of vinyl monomer in which cation is form in **Initiation**, second mole of vinylic monomer is attack on cation in Propagation, and vinylic polymer form in Termination.

B)Condensation or step polymerization mechanism:

- In this mechanism, the polymer molecule builds up proceeds through the stepwise reaction between the reactive functional groups on monomer molecules.
- The reaction takes place slowly in stepwise manner (one after another).
- In most of the cases, there is a formation of simple by product like H₂O, NaCl, R-OH, etc.

The step mechanism has features as:

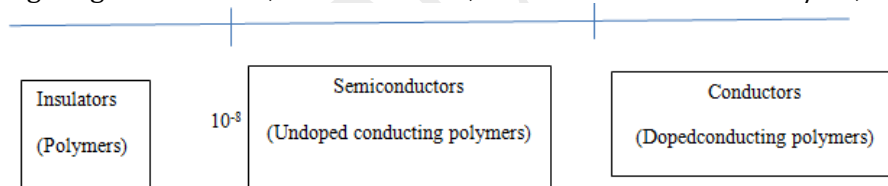
- 1) Catalyst may or may not be required.
- 2) Reaction is endothermic and more the time allowed for reaction longer polymer molecules are produced.
- 3) Reaction between the functional group take places slowly i.e. reacting group on growing polymer chain react with functional groups on monomer, one after another.
- 4) Function group like-COOH, -OH,-COOR, -NH, etc. are on the monomer molecules.
- 5) Molecular formula of polymer is not exact multiple of monomer formula.
- 6) Usually a simple by product is formed along with polymer, therefore by -product Separation is required.
- 7) Mechanism involves a condensation reaction between the functional groups.
- 8) Polymer molecule ends are reactive or live and if more monomers added, the polymerization can continue.

Conducting Polymers:

Organic polymer in general, is bad conductor of electricity, because of non-availability of free electrons.

An extrinsically conducting polymer material is the one which is filled with metal powder, metal filaments or graphite powder.

Conducting range of insulator, semiconductor, and conductor in Siemens/cm, is given below,



Structural requirements:

An organic polymer shows appreciable conductivity if,

- 1) The polymer chain contains conjugation (alternate sigma and pi bonds) throughout its chains, so that there are resonating or mobile electrons for conduction.
- 2) Such polymer is highly crystalline and there is high planarity in structure.
- 3) Presence of aromatic rings in the chain with continuous resonance enhances Conductivity.
- 4) Following polymers show the above mentioned structural requirements.

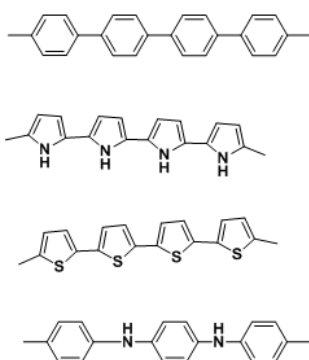


Fig: Polyparaphenylene, Polythiophene, Polyaniline, respectively.

Even though these polymers possess structural favorability, they show only semiconductor character.

1.5. Doping of polymers:

Herger-Mac diramide-Shirakawa (Nobel Prizewinners, 2000) found that the conductivity of polymer chains with conjugation can be increased to the extent of metals, on doping.

In the doping process, the polymer is either oxidized (removal of electrons) or reduced addition of electrons, so that the polymer chain carries the resonating charge. The important doping reactions are given below, for polyacetylene,

(a) Oxidative or P-doping: The oxidizing reagents for P-doping are like iodine vapors dissolved in CCl_4 , HBF_4 , HClO_4 , Br_2 , etc..

The positive charge resonates throughout the polymer chain and can be transferred to the neighboring chains, during the conduction. The conductivity increases up to 10 s/cm.

(b) Reductive or n-doping: The reducing agents for n-doping are like FeCl_2 , lithium sodium, naphthalene, etc.

The negative charge resonates throughout the chain and transferred to neighboring chains the conduction.

(c) Protonic doping: A polymer like polyaniline can be H^+ doping, with acid solution.

1.6 Scope of present work:

The conducting polymers have been widely studied in last two decade, particularly with the aim of finding suitable application for them. Of all the conducting polymers is an attractive material owing to its good electrical, optical, and electrochemical properties and good environmental stability.

Recently the excitement in the conducting polymer research is a rich opportunity for using structural modification to change their properties for large varieties of technological application.

In order to obtain a material which combines the ease of process ability from solution or melt with electrical properties of the metals is the aim of work on conducting polymers. However like many other conducting polymer, polyaniline, is insoluble in common organic solvents. Consequently post synthesis process ability is quite difficult. Much work has been done to improve process ability and conductivity. Among the various method of achieving good solubility, the preparation of polymer from the monomer function with suitable side chain e.g. alkyl anilines, gives soluble high molar mass polymer, however their conductivities are rather low. To obtain soluble and conductive polymer, a series of substituted polyaniline has been chemically polymerized in laboratory.

The polymerization of substituted aniline with the solubilizing monomers leads to a new material which combines the conductivity of the substituted polyaniline and the solubility of the polymer.

The synthesized conducting PANI films show excellent and reproducible sensing behavior against ammonia gas. PANI-Ag₂O film show high sensitivity and reproducibility.

EXPERIMENTAL

In recent year noble metal nanoparticles have been the subjected of focused researches due to their unique electronic, optical mechanical, magnetic and chemical properties that are significantly different from those of bulk material. These special and unique properties could be attributed to their small size and large specific surface area. For these reason metallic nanoparticles have found uses in many applications indifferent field as catalysis, electronic and photonics.

Recently, silver nanoparticles exhibiting antimicrobial activity have been synthesized. Antibacterial activity of the silver-containing material can be used, for example, in medicine to reduce infection aswell as to prevent bacteria colonization on prostheses, Catheters, vascular graft, dental material, stainless steel material and human skin.

Chemicals:

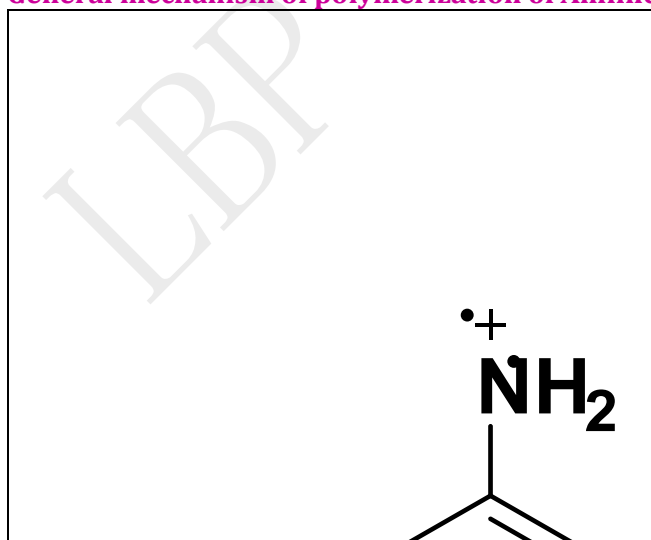
Silver nitrate (AgNO₃), hydrate, Citrate of sodium Dodecyl Sulphate (SDS) was Purchase from merekPeruana. All chemicals were used as received .Double distilled deionized water was used All the chemicals used are of AR grade and purified by distillation.

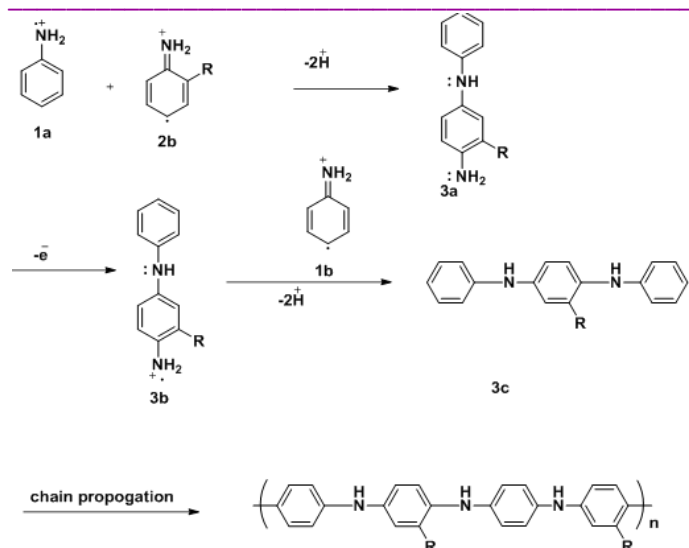
1.2 Synthesis of polyaniline:

Polyaniline was synthesized by polymerization of aniline in the presence of hydrochloric acid (acts as an oxidizing agent) by chemical oxidative polymerization method. For the synthesis, I took 0.1M of aniline and 1.0 M of HCL in double distilled water. These were stirred in a double wall flask at temperatures 0⁺or-1⁰ C. The solution (140ml) of ammonium peroxide sulphate (0.1M in double distilled water) water added drop by drop in the double wall flask during the stirring. After 6 hour, stirring was stopped and the solution was filtered in Butchner funnel (G-4) and the residual was washed 3-4 times with distilled water in the same G-4 funnel. The residual was dried in oven at 60°C for 30 hour and grinded in pestle mortar to get powder from the HCl doped conducting polyaniline.

The HCl doped conductive polyaniline powder was insoluble in any organic solvent so it was treated in ammonia solvent (NH₄OH)to get Undoped polyaniline which was soluble in organic solvent like: N-methyl-2-pyrrolidone. The Undoped polyaniline was washed with methanol to remove the oligomers and the residual was dried in oven at 60°C for 30 hour and ground in pestle mortar to get undoped polyaniline in powder form.

General mechanism of polymerization of Anilines:





INTRODUCTION OF AG:

The nanocomposite with an organized structure usually provides a new functional hybrid, with synergistic properties over their single component counterparts, which have attracted considerable attention for their potential applications.

Conducting polymer nanocomposite possesses the advantages of both low dimensional systems (nanostructure filler) and organic conductors (conducting polymer). The reinforcement of polymers is done by fillers, which play a major role in strengthening the properties of the nanocomposite. Uniform dispersion of the Nano sized filler particles produces ultra large interfacial area per volume between the filler and the host polymer.

The conducting polyaniline (PANI) is one of the promising conducting polymers due to its high conductivity, ease preparation, good environmental stability and large variety of applications which make this polymer suitable as a matrix for preparation of conducting polymer nanocomposite.

It is easily prepared by the oxidation of aniline in aqueous medium. The composites based on conducting polymers and noble metals, such as silver, can be prepared by many ways. Some of the ways are simple blending of both components.

The polymerization of aniline in the presence of preformed metal nanoparticles. The deposition of metal on conducting polymer while using various oxidants, such as glucose.

The reduction of noble-metal compounds with PANI [10-12] and the oxidation of aniline with noble-metal compounds.

From the point of view of PANI nanostructures, last approach is the most interesting. Aniline can be oxidized with noble-metal compounds to produce PANI and corresponding metal at the same time. We present here the preparation of conducting polyaniline/silver nanoparticles (PANI-Ag) nanocomposite by in-situ polymerization of aniline in the presence of silver nitrate as precursor using nitric acid and its characterizations.

2.3 .Synthesis of Ag nano powder:

For the preparation of silver nanoparticles two stabilizing agents, Sodium Dodecyl Sulphate (SDS) and Citrate of Sodium were used. For the synthesis of silver nanoparticles.

Silver nitrate solution (from 1.0 mM to 6.0mM) and 8% (w/w Sodium Dodecyl Sulphate (SDS) were used as metal salt precursor and a stabilizing agent respectively Hydrazine hydrate solution with a concentrate ranging from 2.0mM to 12mM and Citrate of sodium solution (1.0mM to 2.0mM) were used as reducing agents. Citrate of sodium was also used as stabilizing agent at room temperature. The transparent colorless solution was converted to the characteristic pale yellow and pale red colour, when citrate of sodium was used as stabilizing.

RESULT & DISCUSSION

UV-Visible Analysis

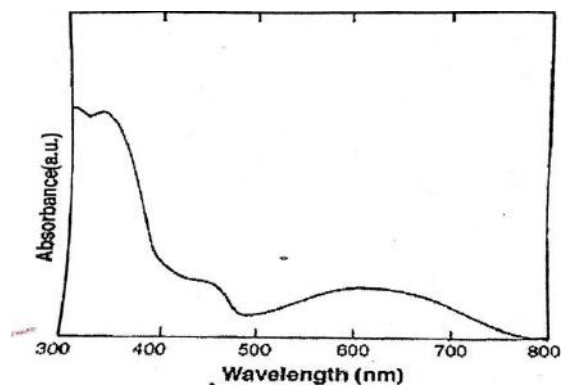


Fig- UV-Visible spectra of Ag.

The structural identification of chemically synthesized polymer can be done with the help of UV-Visible spectroscopy.

UV-visible spectrum of PANI-Ag nanocomposite is shown in figure 4. It reveals that PANI-Ag nanocomposite is typical of emeraldine state with absorption maxima at 332 and 630nm.

The presence of oligomers is identified by the increased absorption at the 332nm with respect to 630nm. Nanocomposite is optically stable in visible range and can be used in optical devices which have linearity in visible range. The blue-shift is attributed to the quantum confinement of charge carriers in the Nano crystals. The optical studies show that the absorption edge of PANI-Ag nanocomposite exhibits the significant blue shift.

3.2.FT-IR Analysis:

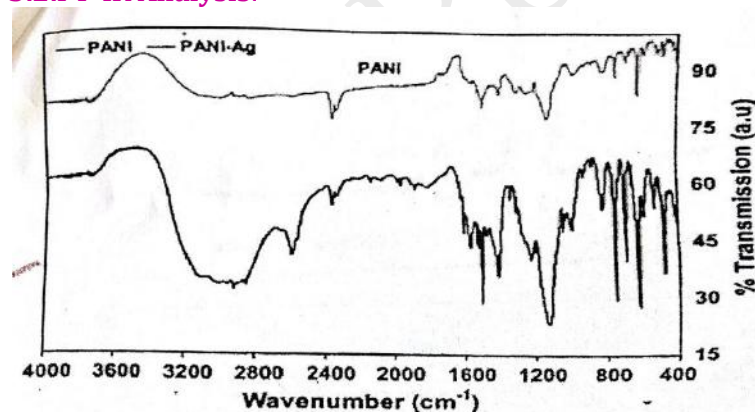


Fig: FT-IR spectra of (a) PANI (b) Ag nano (c) PANI-Ag Composite .

FTIR spectra of PANI-Ag nanocomposite is shown in figure 2. The bands related to N-H stretching of an aromatic amine (N-H stretching) normally appear in the region 3223.40cm^{-1} . The band could be assigned to the asymmetric and symmetric stretching modes of $-\text{NH}_2$ group, respectively. The bands corresponding to quinoid ($\text{N}=\text{Q}=\text{N}$) and benzenoid ($\text{N}-\text{B}-\text{N}$) ring stretching mode were observed

at 1560.6 & 1508.5 cm^{-1} , respectively. Another characteristic band in the infrared spectra refers to quinoic unit at about 1240.4 cm^{-1} arises due to protonation of PANI (I7).

The evidence of formation polyaniline with 1,4-substituted phenyl rings occurred at around 879.6 cm^{-1} . The additional bands at 441.8 and 422.5 cm^{-1} belonging are due to Ag. The spectra of PANI obtained with silver nitrate as an oxidant in nitric acid resembles the product of aniline oxidation using APS. This product is composed of non-conducting aniline oligomers containing phenazine like units and conducting PANI. Scanning electron microscopy images of PANI-Ag nanocomposite are shown in fig. It can be seen from the figure that the fine structure of PANI-Ag nanocomposite is slightly agglomerated and form mostly rod like structure.

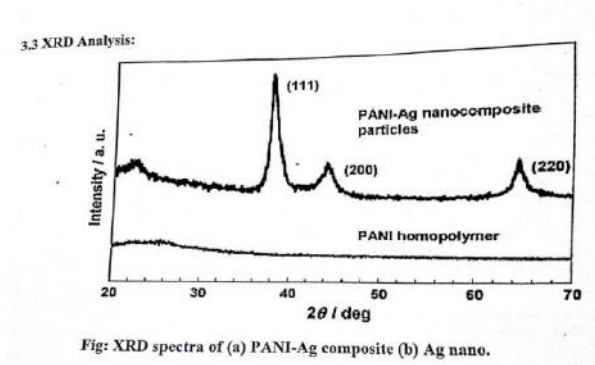


Fig: XRD spectra of (n) PANI-Ag composite (b) Ag nano.

XRD pattern of PANI-Ag nanocomposite is shown in fig. The sharp peak of the XRD pattern indicate that the synthesized nanocomposite is well crystalline and confirms the formation of single crystalline Ag nanoparticles in PANI-Ag. Bragg's reflections at $2\theta = 38.2, 44.3, 64.5$ corresponds to {111}, {200}, {220} lattice planes, respectively, for the face centered cubic (FCC) structure of silver nanoparticles embedded in PANI. The broadening of peaks shows the formation of nanocomposite and the average crystallite size was estimated to be 12nm using Scherer formula.

3.4 Conductivity of synthesized polymer:

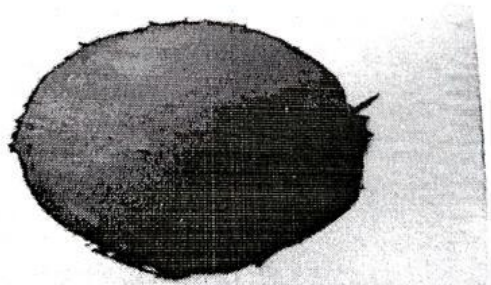
a) Pellet formation

The PANI-Ag₂O product was dried to make moisture free and grind well in the mortar to make fine powder. Then this 110-120 mg powder were taken in the pellet formation instrument of having exact 1 cm inner diameter and pressed under hydraulic pressure machine of about 8-10 tones pressure for 1 min. Because of this high pressure powdered polymer product become compact tablet of 1 cm diameter and 0.2 cm thickness. Like this way every polymer product are made in to- pellet. In between every pellet formation whole instrument should be cleaned very well by acetone to avoid contamination.

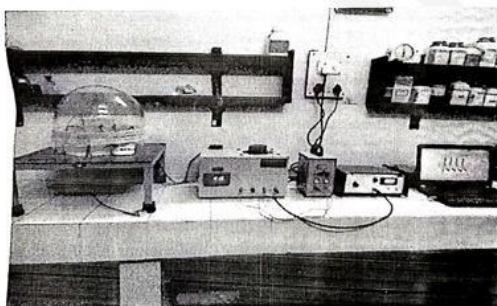


Film preparation:

0.05M NI- Ag₂O with PVA in methanol



Ammonia Gas Sensing:



Sensing Instrument:-

Sensing measurement were carried out in above instrument by exposing the polymer composite film i.e. PANI-Ag composite film to freshly prepared Ammonia solution. The observation in term of resistance was obtained during Ammonia gas sensing were written as below observation table.

Observation Table

Resistance for air (10 ³ Ohm)	Resistance for NH (10 Ohm)
0.375	0.24
0.370	0.23
0.374	0.24
0.371	0.21

Graph of Resistance verses Time:

The graph of resistance verses time shows cycle for air after two minutes and for ammonia gas after thirty second. It shows that when PANI-Ag composite film subjected to ammonia s gives a characteristic response to ammonia gas.

Initially when PANI-Ag composite film exposed to air the resistance was 80 Tera ohm, then PANI-Ag composite film exposed to ammonia gas for 30 sec then resistance increased to 100 Tera ohm similar cycle of reading are repeated for air two minutes and for ammonia gas 30 sec, and 10 cycle reading are taken. It is observed that results obtained are reproducible. The result terpreted in characteristic up and nature in graph.

The PANI-Ag composite produced is acidic in nature contain active hydrogen atoms and ammonia gas is weakly basic in nature, both acidic PANI-Ag composite and weakly basic ammonia Combine together and form neutral complex. This complex formation was indicated by sudden increase in the resistance of the PANI-Ag composite. When this exposed PANI-Ag composite exposed to air the complex formed was breakdown, again the PANI-Ag composite become acidic shows by decrease in the resistance. Again the cycle is goes continuous when exposed to ammonia produced reproducible results.

CONCLUSION:

The film of pure PANI and PANI-silver composite were synthesized by chemical route method. The measured thickness of composite film was in micrometer range .

PANI-Ag nanocomposite was successfully synthesized by simple wet chemical route by colloidal chemistry. PANI-Ag nanocomposite exhibit the significant blue shift. PANI-Ag nanocomposite is well crystalline with average crystallite size of 12nm. SEM study reveals the rod structure surface morphology of PANI-Ag nanocomposite. The combination of PANI as semiconducting polymer with silver as a noble metal may produce hybrid material that behaves as semiconductor at low temperature and as metal at high temperature.

PROPERTIES OF POLYANILINE:

Polyaniline (PANI) is a conducting polymer of semi-flexible rod polymer family. Although the compound itself was discovered ever 150 years ago, only since the early 1980s has polyaniline captured the intense attention of the scientific community. This interest is due to the rediscovery of high electrical conductivity. From the early 20th century on, occasional reports about the structure of PANI were published. Subsequent to his investigation of other highly-conductive organic materials, MacDamid demonstrated the conductive states of polyaniline which arose upon Protonic doping of the emeraldine form of polyaniline. A polyaniline can be found in one of three idealized oxidation states:

Leucoemeraldine-white/clear & colorless $(C_6H_4NH)_N$ emeraldine -green for the emeraldine salt, blue for the emeraldine base $\{[C_6H_4NH]_2[C_6H_4N]_2\}_n$ per nigraniline-blue/violet $(C_6H_4NH)_n$. emeraldine base is regarded as the most useful form of polyaniline due to its high stability at room temperature and the fact that ,upon doping with acid ,the resulting emeraldine salt form of polyaniline highly electrical conducting. Leucoemeraldine and pernigraniline are poor conductors ,even when doped with acid. Treatment of emeraldine with acid increases the electrical conductivity by ten orders of magnitude. The same material is prepared by oxidation of leucoemeraldine. It also has many interesting properties such as environmental stability, controllable electrical conductivity redox properties of associated with chain nitrogen.

Application of conducting PANI-Ag composite:

1. Antibacterial Activity
2. Sensing for other gases
3. Preparation of electronic device
4. Corrosion resistant material

REFERENCES:

- C. Wrenn, Real time measurement of ammonia gas, Occu. Health Saf, 69B, 2000, pp. 64-67.
- R.L. N.Chandrakanthi, M. A. Careem, Preparation and characterization of CdS and Cu₂S nanoparticle/polyaniline composite films, Thin Solid Films, All, 2002, pp. 51-56.
- P.R.Somani, R. Marimuthu, U. P. Mulik, S. R. Mulik, S. R. Sanikar, D. P. Amalnerkar, High piezoresistivity and its origin in conducting polyaniline/ZnO composites, Synth. Met.,106, 1999, pp.45-52
- Y.He, Synthesis of polyaniline/nano-CeO₂ composite microspheres via a solid -stabilized emulsion route, Mater. Chem. Phys., 92, 2005, pp. 134-137.
- S. A Chen, K. R. Chuang, C.I.Chao, H. T. Lee, White light emission from electroluminescence diode with polyaniline as the emitting layer, Synth. Met., 82, 1996, pp. 207-210.
- G.MacDiarmid, L. S. Yang, W. S. Huang, B. D. Humphrey, Polyaniline: electrochemistry and application to rechargeable batteries, Synth Met., 18, 1987, pp. 393-398 .
- D. Verma V. Datta, Role of novel microstructure of polyaniline-CSA thin film in ammonia sensing at room temperature, Sens. Actual B, 134, 2008, pp. 373-376.
- M. Mastuguchi, A. Okamoto, Y. Sakai, Effect of humidity on NH₃ gas sensitivity of polyaniline blend films, Sens. Actuators B, 94, 2003, pp. 46-42.
- F.Y.Chaung, S. M Yang, Titanium oxide polyaniline core-shell nanocomposites, Synth. Met, 152,2005, pp. 361-364.
- Z. Sadek. W. Wlodarski, K. Shin, R. Bkaner, K. Kalantar-zadeh, A layered surface acoustic wave gas sensor based on a polyaniline/In₂O₃ nanofibre composite, Nanotechnology, 17, 2006, pp. 4488-4492
- D. S. Dhawale. R.R. Salunkhe, U. M. Pati, K. V. Gurav, A. M. More, C. D. Lokhande, Room emperature liquefied petroleum gas (LPG) sensor based on p-polyaniline/n-TiO₂ heteroj unction, Sens. Actual B. 134, 2008, pp. 988-992.
- H. Tai, Y. Juang, G. Xie, J. Yu, X. Chen, Fabrication and gas sensitivity of polyaniline- titanium dioxide, 12 nanocomposite thin film, Sens Actuators B, 125, 2007, pp. 664-650.

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