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MERITS AND DEMERITS OF CONDUCTING POLYMERS

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Abstract

Intrinsically conducting polymers were found approximately three decades ago, and this finding has drawn the attention of researchers due to the numerous applications of these polymers in the scientific field. Because of their electrical conductivity, which is comparable to that of metals, these are also known as synthetic metals. Polyacetylene has a linear polyene chain as its primary chain. If you want to make a mono- or distributed polyacetylene, you can change the hydrogen molecules in the carbons between them. This makes it possible to make a mono- or distributed polyacetylene. Polymers that conduct electricity have been getting a lot of attention because of their unique features. These features include tunable electrical properties, high optical and mechanical abilities, easy synthesis and fabrication, and better environmental durability than typical inorganic materials. If you combine conducting polymers with other materials, you can get around some of their flaws in the way they are in their natural state.

Keywords: **Merit, demerit, Conducting, Polymer, etc**

1. INTRODUCTION

Intrinsically conducting polymers were found approximately three decades ago, and this finding has drawn the attention of researchers due to the numerous applications of these polymers in the scientific field. Because of their electrical conductivity, which is comparable to that of metals, these are also known as synthetic metals. Polyacetylene, polyfuran, polypyrrole, and polythiophene are examples of numerous conducting polymers (CPs) that are in sulaters in their neutral form (Figure 1). Polymers' insulating properties can be transformed to conducting properties by using chemical and electrochemical redox processes to dope various salts. Walatka et al. found Polysulfur nitride [SN]x was made in 1973. In the late 1970s, MacDiarmid, Shirakawa, and Heeger made organic polyacetylene that was made by chemical polymerization more semiconducting. Halogen derivatives were added to polyacetylene by their work in 1977. It was published in the chemical communication journal. In 2000, these three scientists were given the Nobel Prize in Chemistry for their work on conducting polymers, which they made (CPs). Scientists became interested in making more conducting polymers after they found polyacetylene, which is made of polythiophene, polyaniline, polypyrrole, and polyfuran. Because these polymers can be treated at low temperatures, they aren't like metals, which can't be done. however the fundamental issue with these polymers is their stability.

These polymers' conducting properties are inherent, as they are owing to their structure rather than the addition of any conducting elements. Heeger and his colleagues first employed polythiophene to make devices for electronic devices in 1987, and then high-efficiency LEDs based on polymer in the 1990s. In 2003, these polymer LEDs were used to make emission displays that were used in cell phones, like the ones on this picture. They can be used in more ways if they are mixed with other materials that are useful. In physics, they are used to make things like transistors, computers, and biomedical science work. A lot of scientists have been working on ways to use conducting polymers since they were discovered in the late 1970s. These include thin-film transistors (also known as polymer light emitting

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diodes) and electrochromic devices that change colour when they're exposed to certain types of light. It is possible to make molecular structures that can be used for almost any kind of job. application by carefully selecting molecule combinations.

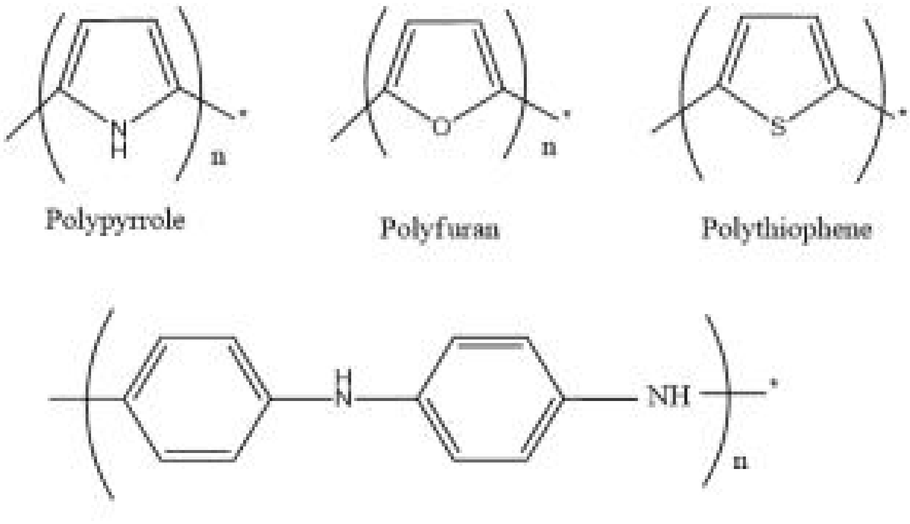


Figure 1: Examples of Intrinsically Conducting Polymers

Conducting polymers with metal particles have a variety of intriguing scientific and practical features. Over the last few decades, researchers have focused more on conducting polymer composites in order to discover new features not seen in separate materials. Conducting polymers that have three-dimensional structures are more interesting to scientists than hybrid and nano hybrid materials, which have a lot of different parts. When you add metal, metal oxides, graphene, and graphene oxide to conducting polymers, you get hybrid and nanohybrid polymers that are both conducting and non-conducting. These new materials are better at a lot of things, like sensors, electronic devices, and biological applications. During the process of making capacitors, the graphene nano hybrid of these polymers is used as an electrode for the device. These nanohybrid materials make capacitors more stable, flexible, and capacitive. Such polymers can be put on metal by either chemical or electrochemical means. Doping can improve the thermal stability, mechanical properties, conductivity, corrosion resistance, and other qualities of polymers. It can also make steel and aluminium more resistant to corrosion. In general, doped conducting polymers are better at protecting metal surfaces from corrosion than undoped conducting polymers. This is because they make a good environment for corrosion protection on metal surfaces by preventing corrosive agents from moving or forming a uniform passive layer of doped polymers on metal surfaces.

1.1 Conducting Polymer Properties and Applications

Conducting polymers are used in a wide range of applications, including supercapacitors, electrochromic devices, biosensors, and electrocatalysts. Because of their electro-optical properties, conducting polymer nano-composites of inorganic oxides have a wide field of applications in chemistry and physics. Figure 2 depicts many applications and features of conducting polymers.

ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

Dopant anions improve several aspects of conducting polymers, including prosessibility, conductivity, permeability, and mechanical qualities.

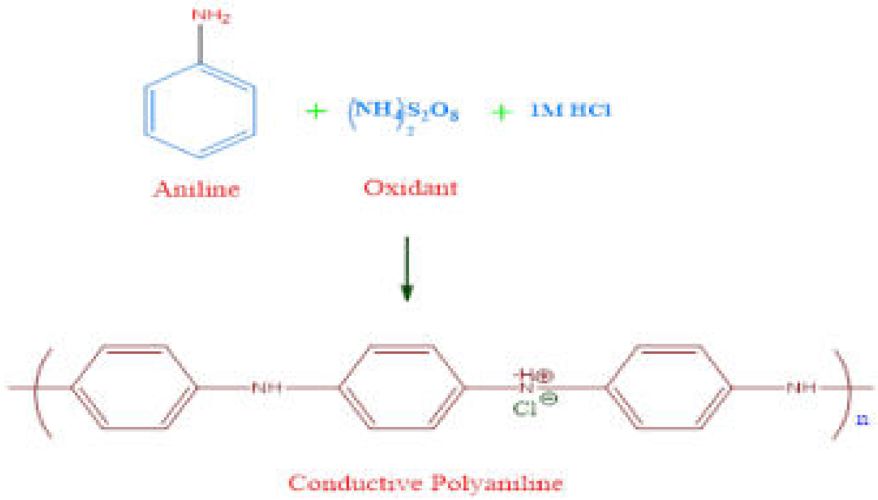


Figure 2: Applications and Properties of Conducting Polymers

- **Electrical properties:**

Because of their high conductivity, conducting polymers are used in a variety of electronic devices such as batteries, solar cells, fuel cells, and super capacitors. CPs is used in a variety of ways, as described below.

i. **Lithium ion batteries:** Conducting polymers have been employed in the manufacture of lithium ion batteries. Several polymers are employed as electrodes in batteries, including polypyrrole, polyaniline, and polyacetylene. In lithium ion batteries use PPy composites that have been doped with MnCo2O4 as anodes. In this case, the composites are very stable. They have a high performance rate, and they're very light in weight. Electric vehicles, smart phones, and tablets all use these batteries.

ii. **Solar cells:** Conductive polymers have been used to make solar cells. In solar cells, these are used as an electrocatalyst. When making solar cells, PPy aluminium oxide composites were used as an electrocatalyst. Instead of silicon solar cells, dye-sensitized and photovoltaic solar cells made of conducting polymers are being used instead, utilized because they have higher energy conversion efficiency and are less expensive. These are also utilized in solar cells as energy transfer mediators.

iii. **Fuel cells:** Over the last few decades, Fuel cells have shown that they can be used in electric vehicles and cars for a number of reasons. High and low temperature polymer fuel cells are two types of the same type of fuel cell: Use polymer membranes to make very hot fuel cells (benzamidazoles). Direct methanol fuel cells (DMFCs) have been used in the field of energy, and they have worked well. Conducting polymers with 1D-nanostructures are used as electro catalytic supports in cell cells to help them work because of their fuel mobility and high energy conversion efficiency.

ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

- **Light Emitting Diodes (LEDs):** People could use conducting polymers like Poly(p-phenylenevinylenes) and Poly(dialkylfluorenes), as well as their derivatives, in polymer light emitting diodes (PLEDs). If you add bulky phenyl side groups to the polymer, you can make the PLEDs work better.

- **Anticorrosion properties:**

Conducting polymers and their composites are now commonly employed as corrosion inhibitors on metal surfaces. The ability of these composites to restrict the flow of corrosion-causing chemicals on metal surfaces accounts for their corrosion-protecting properties. The development of a passive film by the polyanilne coating on steel surface protects it against corrosion, according to research. The corrosion inhibiting properties of a polyaniline epoxy mixed coating on steel have been investigated. On mild steel surfaces, polyaniline/polypyrrole and polyaniline-polypyrrole phosphotungustate composites were utilized as corrosion inhibitors. Composite films outperform bare polyaniline and polypyrrole in terms of corrosion resistance.

2. REVIEW OF THE LITERATURE

Yan Wang, Minggang Yao, Rong Ma, and Qibin Yuan et al (2019) with the concerns of resource use and environmental impact, energy conversion and storage has received more attention. are a lot of academic studies going on right now about making flexible nanodielectric materials with a lot of energy density, which has a lot of real-world applications. In this case, the nanocomposite film is made of barium titanate and polyvinylidene fluoride (BT/PVDF). These materials have good physical, chemical, and electrical properties, and they can be used in many different ways. Researchers who have looked into high energy density BT/PVDF-based nanocomposite films are grouped and summarised in this study. The process of increasing the energy density of BT/PVDF-based nanocomposite films by using different techniques is explained. This paper's goal is to explain why BT/PVDF-based nanocomposites have a higher energy density and come up with a new way to make BT/PVDF-based nanocomposites with a higher energy density. Finally, a summary of the BT/PVDF-based nanocomposite for energy storage films is given, along with a forecast for the future and issues that need to be solved. Improve raw materials, multiphase doping, three-dimensional modulation, and process optimization, with three-dimensional modulation being the focal point.

Yongfang Li, Yongfang Li, Yongfang Li (2015) the oxidised conducting polymer is a conjugated polymer that has been doped with counter anions and another example is a semiconducting polymer. A conductor is a material that can be used to make things that can be both electrical and optical. Conducting polymers also have the flexibility and processing ability of polymers. The discovery of conducting polymers was made in 1977. Since then, research on conducting polymers has moved quickly and has been expanded into a lot of different fields. They've been getting a lot of attention in the last 25 years because they can be used in things like light-emitting diodes, polymer solar cells, and more. Doped conducting polymers, which can be used as transparent electrodes, electrode buffer layers, modified electrodes, and electrochemically modified electrodes, have a lot of new scientific findings and applications super capacitors, and other applications have piqued researchers' curiosity. In this chapter, I'll begin by discussing the history of conducting polymers' discovery and

ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

development, and then I'll concentrate on the molecular structures, basic physicochemical features, and preparation methods of conducting polymers.

Syed Gulrez, M. Ali Mohsin, Hamid Shaikh, Arfat Anis, Poulose, et al (2014) Conductive polymers are a new class of functional materials that could be used in the electronics, aerospace, and aviation industries. The Polypropylene (PP) and polyethylene (PE), two of the most common, widely available, and cheapest thermoplastics, can change the field of engineering thermoplastics if they can be made to be conductive. In this article, we talk about how to make electrically conductive PP and PE that can be used for electromagnetic interference/radio frequency (EMI/RF) shielding and to keep electrostatic discharges from happening (ESD). It looks at the many types of filler that researchers use to make conductive PP and PE, as well as the different elements that affect thermoplastic composites' electrical conductivity and the different processing methods that can be used to make them. It talks about how to make conductive composites, how they're made, and how they work. It also talks about the electrical properties of the finished product. The percolation threshold has been looked at very closely, as well as ways to lower it, in order to make PP and PE-based composites with low filler loading that have a lot of electricity.

Murat Ates, Tolga Karazehira, and A. Sarac (2012) conducting polymers and their applications are the subject of this review article. Since its discovery in 1977, conducting polymers (CPs) have piqued people's imagination as an interesting new family of electronic materials. When they are compared to non-conducting polymers, they have a lot of advantages because of their electrical and optical properties. They've also been used to make artificial muscles, electrical devices, solar energy conversion, rechargeable batteries, sensors, and other things, like sensors and sensors. In this study, there are two parts to it. The first is about polymers that can conduct electricity (polythiophene, polyparaphenylene vinylene, polycarbazole, polyaniline, and polypyrrole). LEDs, solar cells, field effect transistors (FETs), biosensors, and supercapacitors are some of the things that can be used to make electricity. are examples of their uses. Both portions have been completed and summarized, including 233 references that have recently been evaluated.

Haghi, A.K. (2009) an intrinsically conducting polymer (ICP), also known as synthetic metal, is a type of organic polymer that can be used to make electricity magnetic, and optical properties as a result of a doping/de-doping process similar to that of a regular polymer. The use of ICPs in various types of sensors, transistors, and display devices is discussed in this work. Despite the fact that ICPs have a wide range of applications, we're concentrating on the ones that are most intriguing to us. The focus is on significant advancements in the above-mentioned field in the recent 5-10 years. Traditional inorganic transistors are likely to be outperformed by polymer-based transistors. Furthermore, a simple approach employing organic ICPs can replace the difficult procedure of fabricating inorganic transistors. Electrochromic display devices are ideally suited for ICPs (ECDs). Depending on the oxidation-reduction state, they have varied colors. A sensor's job is to deliver data about the physical, chemical, and biological environment. ICPs can be used to make biosensors, gas sensors, humidity sensors, and ion sensors, among other sorts of sensors.

3. OBJECTIVES

- To study Polymer Properties and Applications.

ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

- To investigate conducting polymers exact advantages over other materials and their synthesis.

4. CONDUCTING POLYMERS SPECIFIC ADVANTAGES OVER OTHER MATERIALS

The advantages of conducting polymers over other materials:

- **Range of conductivity:**

Polyaniline-based conductive polymer compositions can be very precise about how electrically conductive they are across a wide range. As long as the polyaniline mixture is clean, it can have a conductivity level of up to 100 S/cm. It's possible to make polymer blends that have conductivity levels that range from less than 10-10 to 10-1 S/cm (melt processing) and 10 S/cm (solution processing). globular carbon black does not have the traditional high percolation threshold for the start of electrical conductivity, which is why it does not start to conduct electricity packed polymers is a significant advantage.

- **Material that can be melted or dissolved in a solution:**

Traditional procedures can be used to process polyaniline-based conductive polymer compositions. These materials can survive temperatures as high as 230 - 240°C for short periods of time (5-10 minutes) without losing their electrical characteristics, and they can be melted mixed with a variety of common polymers. For solution processing clean polyaniline compounds, a variety of industrial solvents can be employed.

- **Conductive mixes using a wide range of common polymers:**

Common solution and melt processing procedures can be used to create electrically conductive polyaniline blends with item polymers. Polyethylene, polypropylene, polystyrene, PVC, phenol formaldehyde tars, and many types of thermoplastic elastomers are instances of item polymers. The mechanical properties of mixes are like those of the protecting grid polymer, unlike traditional filled composites.

- **Function as processing aids in addition to providing conductivity:**

Plasticized materials increase dissolve handling execution by bringing down liquefy thickness, handling temperature, and handling time. Further developed liquefy stream characteristics make infusion embellishment of mind boggling calculations, for instance, simpler.

Electrically conductive coloured and translucent products:

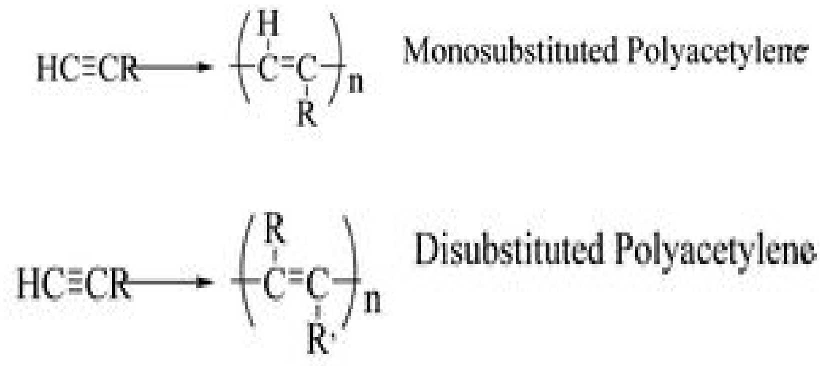
Polyaniline-based structures can be utilized to make electrically conductive, shaded, and straightforward flimsy movies and coatings that would somehow or another be challenging to acquire with conventional filled materials.

5. CONDUCTING POLYMERS AND THEIR SYNTHESIS

5.1. Polyacetylene

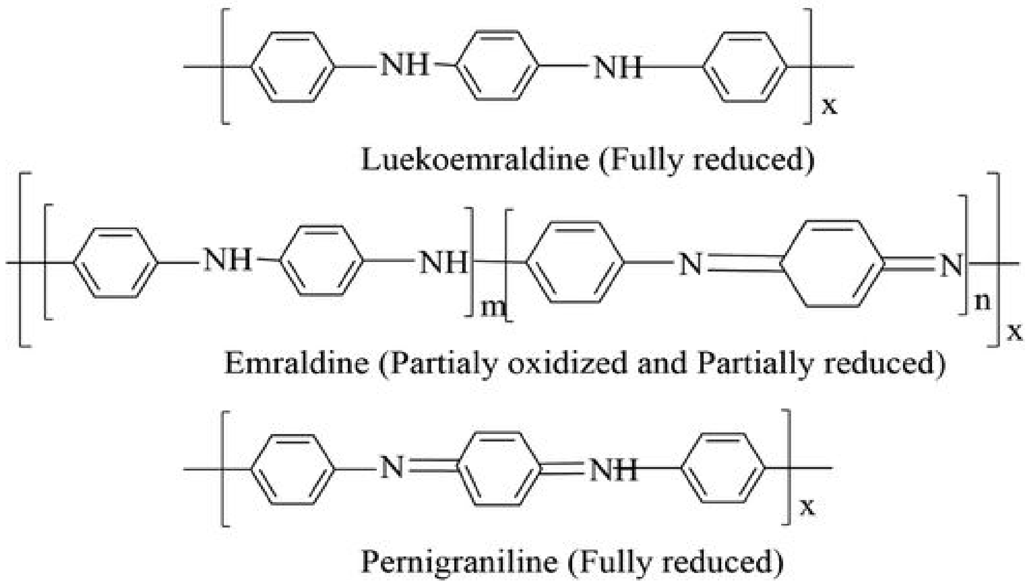
ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

The Nobel Prize was granted for the formation of polyacetylene doping and its increment of conductivity. Polyacetylene and its subsidiaries have a wide scope of utilizations. Electrical conductivity, photoconductivity, fluid precious stone properties, and chiral acknowledgment are a portion of the qualities that can be researched intently. Polyacetylene has a straight polyene chain as its essential chain. It is pliant and might be embellished with pendant gatherings, and that implies that the hydrogen atoms in the substituting carbon can be supplanted with an unfamiliar particle to create a mono-or disubstituted polyacetylene.



5.2 Polyaniline

Polyaniline is the most promising and researched conducting polymer, with great stability, processability, and tunable conductivity and optical characteristics. Polyaniline conductivity is proportional to the dopant concentration, and it only exhibits metal-like conductivity when the pH is less than 3.23. Polyaniline comes in a variety of forms (fig. 3). By their oxidation state, they are classed as leucoemeraldine, emeraldine, and pernigraniline, with leucoemeraldine being sufficiently reduced and pernigraniline being totally oxidized. When polyaniline is partially oxidized, it becomes conductive, but when fully oxidized, it behaves as an insulator.



ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

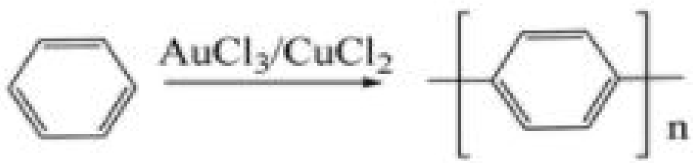
Figure 3: Structural illustration of different forms of polyaniline

5.3 Polypyrrole

Polypyrrole is unique in that it has increasing economic interest due to its high stability, improved conductivity, what's more, simplicity of homopolymerization and composite development. Polypyrrole is a dark fine material that is made by artificially oxidizing a pyrrole monomer within the sight of hydrogen peroxide. When doped with halogenic electron acceptors like bromine or iodine, polypyrrole acts like a protecting material in its undoped virgin state and has a steady conductivity of 10-5 s m-1.

5.4. Poly(p-phenylene)s

You can think of poly(p-phenylene) as a big molecule that has benzoid aromatic nuclei linked together by C–C bonds. Poly(p-phenylene)s are getting a lot of attention because they have great thermal stability, air stability, doping ease, and a wide range of conductor and optical properties you can change. In the field of nonlinear optics, the stiffness of the polymer backbone combined with conjugation could be a big step forward. Flexible side chains are added to the backbone of poly(p-phenylene)s, which makes them more soluble. When the right dopants are used, the conductivity of poly(p-phenylene) goes up 14 times, and it can be both p-type and n-type doped. It gets better as the dopant is exposed. period increases.



6. CONCLUSION

Conducting polymers stand out enough to be noticed on account of their exceptional highlights, which incorporate tunable electrical properties, high optical and mechanical abilities, simplicity of union and manufacture, and better natural solidness than common inorganic materials. Despite the fact that directing polymers have various disadvantages in their regular express, these can be overwhelmed by joining them with different materials.Because of their relative simplicity of synthesis, strong environmental, chemical, and thermal stability, and simple acid/base doping chemistry, polyanilines are appealing as conducting polymers. It will be necessary to synthesis these materials at a low cost in order to use them in commercial applications. The use of aqueous solutions and low-cost starting materials opens up the possibility of generating polyanilines in bulk, in the form of powder, with properties similar to those of anodic oxidation-produced polyaniline films. Polyanilines are used in a wide range of microelectronics applications. They've been proven to provide an effective, easy spin apply technique for charge dissipation in lithography, especially for e-beam lithography and SEM metrology. The commercial availability and cost of these polymers will determine their use in this field.

ISSN- 2394-5125 VOL 08, ISSUE 02, 2021

REFERENCES

1. Wang, Yan & Yao, Minggang & Ma, Rong & Yuan, Qibin & Yang, Desuo & Cui, Bin & Ma, Chunrui & Liu, Ming & Hu, Dengwei. (2019). Design Strategy of Barium Titanate/Polyvinylidene Fluoride-based Nanocomposite Films for High Energy Storage. Journal of Materials Chemistry A. 8. 10.1039/C9TA11527G.

2. Li, Yongfang. (2015). Conducting Polymers. 10.1007/978-3-319-16862-3_2.

3. Gulrez, Syed & Ali Mohsin, M. & Shaikh, Hamid & Anis, Arfat & Poulose, Anesh & Yadav, Mukesh & Qua, Patrick & al-zahrani, Saeed. (2014). A review on electrically conductive polypropylene and polyethylene. Polymer Composites. 35. 10.1002/pc.22734.

4. Ates, Murat & Karazehira, Tolga & Sarac, A.. (2012). Conducting Polymers and their Applications. Current Physical Chemistry. 2. 224-240. 10.4028/www.scientific.net/MSF.42.207.

5. A.K., Haghi. (2009). Conducting polymers. Journal of the Balkan Tribological Association. 15. 141-155.

6. Gao F, Hou X, Wang A, Chu G, Wu W, Chen J, Zou H. Preparation of Polyyrrole/TiO2 nanocomposites with enhanced photocatalytic performance, Particuology Particuology. 2016; 26:73-78.

7. Zhang H, Liu Y, Wu J, Xin B. One step preparation of Fe3O4/Pd@ polypyrrole composites with enhanced catalytic activity and stability, Journal of Colloid and Interface SciencZ. 2016; 476:214-221.

8. Ates M, Sarac AS. Electrochemical impedance spectroscopic study of poly - thiophene on carbon materials, Polymer - Plastics Technology and Engineering. 2011; 50(11): 1130-1148.

9. Keles H, Solmaz R, Ozcan M, Kardas G, Dehri I. Copper modified poly-6-amino m-cresol (poly-AmC/Cu) coating for mild steel protection, Surface & coating Technology. 2009; 203:1469-1473.

10. Ryu KS, Lee Y, Has KS, Park YJ, Kang MG, Park NG, Chang SH. Electrochemial supercapacitor based on polyaniline doped with lithium salt and active carbon electrodes, Solid State Ionics. 2004; 175:765-769.

11. Bendrea AD, Cianga L, Cianga I. Progress in the field of conducting polymers for tissue engineering applications, Journal of Biomaterials Applications. 2011; 26:3-84.

12. Zhao Y, Cao L, Li L, Cheng W, Xu L, Ping X, Pan L, Shi Y. Conducting Polymers and Their Applications in Diabetes Management, Sensors. 2016; 16:1787-1801.