SJIF Impact Factor: 7.001| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 5 | Issue: 10 | October 2020 - Peer Reviewed Journal

SYNTHESIS OF CONDUCTIVE POLYMERIC COMPOSITIONS BASED ON POLYANILINE

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ABSTRACT
In this research polymer compositions with metal oxides were synthesized using the chemical oxidation method. The effect of oxidation concentration and polymerization temperature on PANI yield was studied. The results obtained showed that the inclusion of Fe_2O_3 and V_2O_5 in polyaniline leads to an increase in their current conductive ability.
KEYWORDS: *aniline; polyaniline; emiraldine salt; polymerization; oxidizing; conduction; metal oxides.*

INTRODUCTION
In recent years, there has been a growing interest in conductive polymers such as polyaniline, polythene, and polypyrrole [1].

Conductive polymers are used in various fields due to their excellent conductivity, low density, stability and corrosion resistance, electrochemical and optical properties, as well as low cost. For example, it is used in batteries, electromagnetic coatings, chemical sensors, biosensors, nanocomposites, light emitting diodes, electrochrome screens.

The conductivity of polymers is related to the state of redox, which changes the electronic structure of the polymer. Conducting polymers have a highly delocalized π -electron system, which is formed by one and two bonds in the main chain of the polymer. Therefore, the oxidation and reduction processes can proceed easily [2,3]. The electrical conductivity of such polymers is called "own" because there is an electrical charge in the molecular structure that can move along the polymer chain without other conductive materials (such as metals and graphite). Presumably, these materials can be dielectric in the neutral state. The electrical conductivity of such polymers is due to the interaction of the dopand molecule with the electrically non-conducting part of the polymer chain. This process is called "doping". The amount of Dopand molecule can be up to 50% of the mass of the conductive polymer. Dopant interacts directly with the polymer, and the conductive charge does not play a role. There are two types of doping: P-type doping and N-type doping.

In N-type doping, the polymer loses electrons and this increases the conductivity of the polymer, a process known as polymer reversal. P-type doping, on the other hand, is called polymer oxidation and is widely used in the semiconductor industry. Chemical or electrochemical methods are used to change these properties of polymeric materials. Chemically, an oxidizer or reductant is added to the polymer.

Polyaniline (PANI) is one of the most promising of these polymers. Currently, this polymer is a leader in the manufacture of conductive and corrosion-resistant coatings, in electronic publications related to the study of its properties and structure for use in various electrochromic and electrolyuminescent devices and other electronic devices [4].

PANI is one of the electrically conductive polymers of the class of organic semiconductor high-molecular compounds. The PANI macromolecule consists of a basic polymer chain consisting of a linear benzene nucleus and a nitrogen atom attached

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to it. The multi-conjugated π -electron system in the Pani macromolecule is caused by the interaction of nitrogen atoms bonded to the benzene nucleus in the main polymer chain. Charging positive poles are introduced into the polymer by chemical or electrochemical oxidation method. Stabilization of the poles with strong acids results in delocalization of charge carriers and an increase in electrical conductivity. The oxidation state of PANI and the degree of protonation using acids can take many forms [5]. PANI mainly occurs in 3 different states: Leukoemyraldine ($y = 1$), Emiraldine ($y = 0.5$), Pernigranilin ($y = 0$), which differ in color and electrical conductivity [6].

In the production of PANI mainly polymerization methods by electrochemical and chemical oxidation are used. Today's scientific studies show that aniline can also be polymerized by enzymatic methods, but the synthesis of PANI under acidic conditions reduces the activity of enzymes (eg, horseradish peroxidase), resulting in a decrease in the conductivity of the obtained PANI, second method used.

Due to a number of useful properties of PANI polymer compositions obtained with inorganic fillers, they are widely used in electronics and electrical engineering. Hybrid materials consisting of organic and inorganic nanocomponents are in great demand in the field of microelectronics. They are highly sensitive to light, various gases, catalytic active substances [7, 8].

In this study PANI va PANI/V_2O_5, PANI/Fe_2O_3were synthesized.

RESEARCH METHOD

PANI was synthesized by chemical oxidation without the addition of any acid. This method allows to obtain PANI without the use of special high-acid reagents, thereby not only increasing the corrosion resistance, but also reducing the complexity of the method and increasing its environmental friendliness [9, 10].

To obtain PANI, potassium persulfate salt, which is a chemical oxidant, is dissolved in distilled water and stirred vigorously for 15-20 minutes. Aniline is added dropwise while stirring constantly. Samples are stored at constant $T = 30^{\circ}C$ with time interval $t = 5$-48 hours. Distilled water is added to the reaction mixture and the powdered PANI is precipitated. The precipitated PANI is separated from the solution using a syenrafuga. The separated PANI powder is separated by washing with distilled water and re-cyanurizing to remove impurities. The process is repeated several times and dried in a PANI thermostat at 30°C (T = const). PANI.

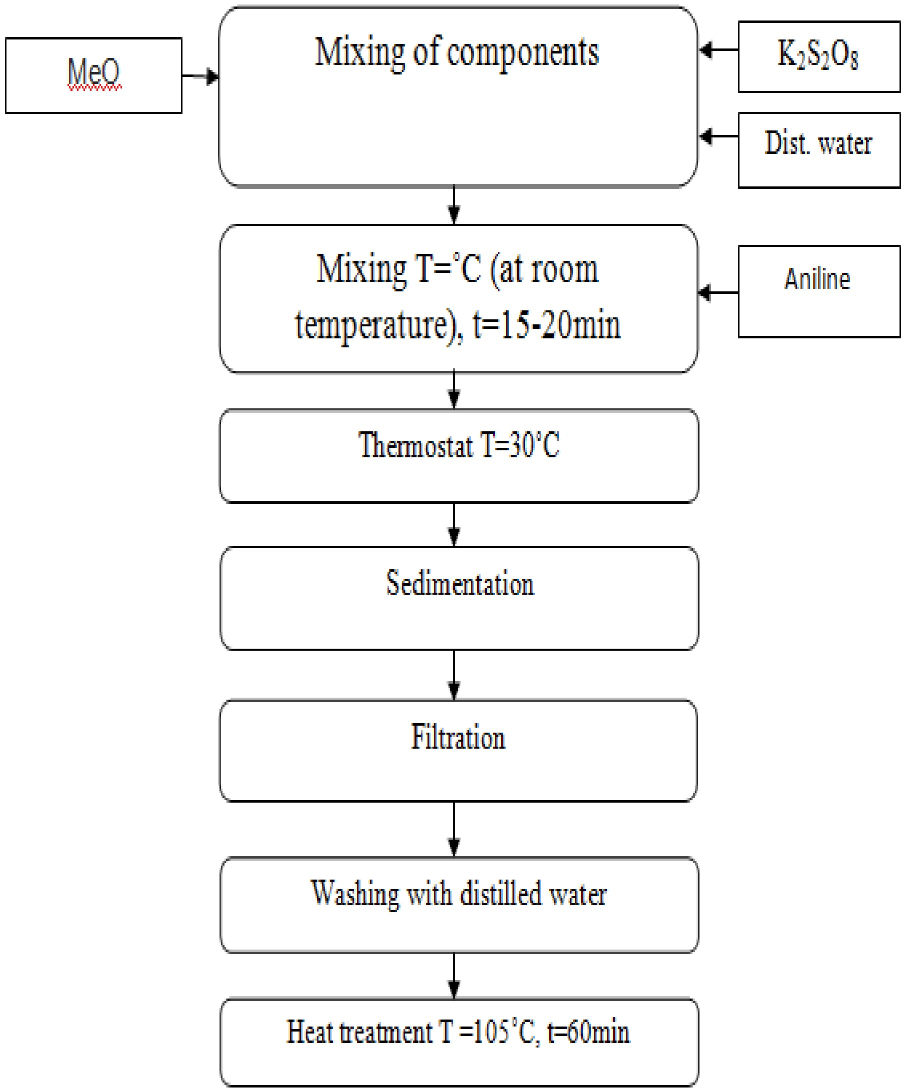

Figure 1. Technological scheme of obtaining PANI and PANI / MeO composition.

The synthesized PANI structure was determined based on their IR spectrum. According to the IR spectrum data, all the main absorption spectra in PANI are preserved, characteristic for the monomer: 3428 cm^{-1} (NH valence oscillation), 3010 cm^{-1} (CH valence oscillation in the benzene nucleus), 1637 and 1491 cm^{-1} (correspondingly benzoid, SS deformation oscillation of quinoid structures), 1165 cm^{-1} (deformation deformation oscillation of SN-group). However, for PANI samples, there is a significant difference in the field intensity between 1630 and 1494 cm^{-1}. Absorption region 1310 cm^{-1} (valence oscillation for S-N secondary aromatic amine), in the case of aniline, this absorption line is 1281 cm^{-1}. The PANI spectrum also clearly shows the absorption line in the 601 cm^{-1} region, which is due to the effect of the N-H bond on the secondary aromatic amine (764 cm^{-1} absorption line for the N-H bond in the aniline spectrum).

Studies have shown that the oxidation concentration and the temperature of the reaction mixture have a significant effect on the yield of PANI synthesis, which can be seen in Figure 2 below.

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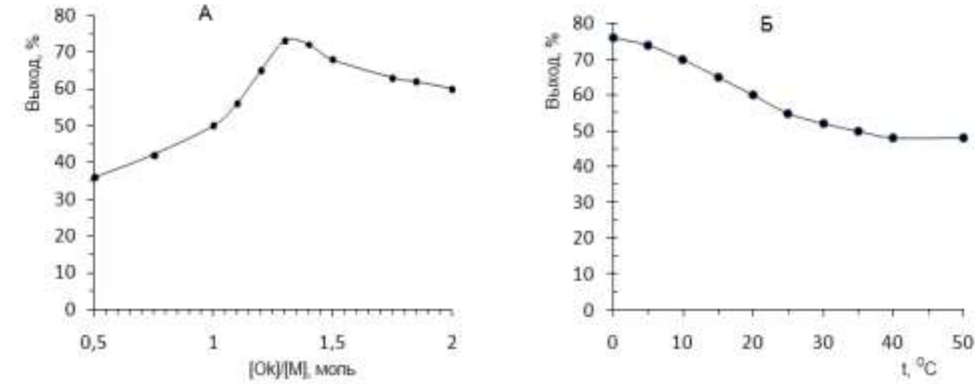

Figure 2. Oxidation to PANI yield: effect of monomer mole ratio (A) and reaction mixture temperature (B).

Research on PANI sampling has shown that they exhibit poor electrical conductivity. Therefore, several metal oxide compositions were obtained with PANI. Figure 3 shows the electrical conductivity of polymer compositions derived from PANI /V_2O_5 va Fe_2O_3.

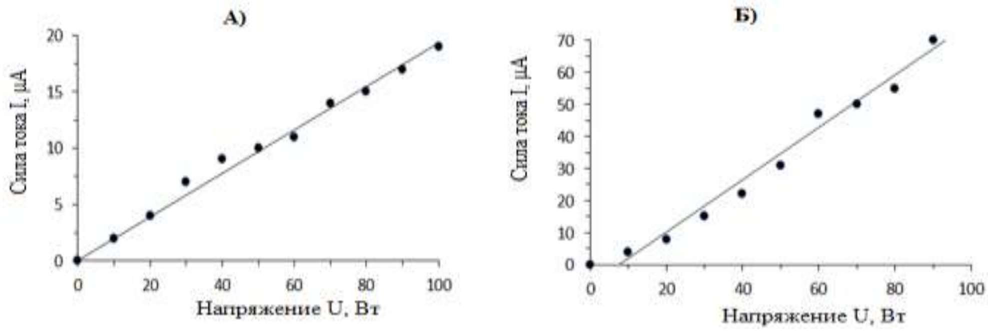

Figure 2. Voltage dependence of electrical conductivity ofPANI/V_2O_5(A) va PANI/Fe_2O_3compositions.

Figure 2 shows the current conductive ability of the PANI/Fe_2O_3composition. PANI/V_2O_5 is much higher compared to PANI/Fe_2O_3.

Studies have shown that the electrical conductivity of polymer compositions increases with increasing temperature.

In this study, polymer compositions based on PANI and metal oxides (Fe_2O_3, V_2O_5) were siteed. The dependence of the initiator concentration and the polymerization temperature on the polymer yield was shown. The inclusion of metal oxides in PANI has been shown to increase their electrical conductivity.

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