Comparative Thermal study on Synthesis of Polypyrrole via Different Oxidants

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Abstract

For the purpose of synthesizing polypyrrole the process of oxidative polymerization of chemical nature was adopted with different oxidants. Pyrrole monomer (which was taken in different moles each time). Further oxidizing agent as well as surfactant was added in the beaker. The various concentrations of the monomer taken for the purpose along with the concentrations of the surfactant as well as that of oxidizing agent like $FeCl_3$, $(NH)_4S_2O_8$, $C_{12}H_{25}SO_4Na$ are used. Synthesized all polymer will be comparatively analysis by TGA

Keywords: Conductive polymer, Polypyrrole (PPy), Chemical oxidative polymerization, Polymerization technique

1. Introduction

Polymeric based materials in general being considered as lighter weight and insulating materials. Current development on the use of polymer materials shown that the polymer has met a variety of applications which are not limited only being used as passive materials due to its isolative properties, but also being used as active materials that hold optical, conducting, and electromagnetic properties .Among them, polyaniline (PANI), Polypyrrole (Ppy) and polythiophene (PT) are considered potential candidates for development of conducting polymer type materials. However, large attentions have been given to the Ppy because in addition to its high electrical conductivity value, Ppy is chemically stable with good mechanical properties and can be synthesized through a simple process. Not surprisingly, the conducting Ppy has met applications in various areas like light-weight batteries, electronic devices, sensors and membrane separation . Another potential application areas of Ppy are drug delivery, rechargeable batteries, supercapacitors, microwave shielding and corrosion protection[1-4] .

The preparation of conducting polymer is mostly carried out either through chemical reaction or electrochemical method[5-6].

2.Material and Methods

For the purpose of synthesizing polypyrrole the process of oxidative polymerization of chemical nature was adopted. One hundred milliliters of distilled water was taken in a beaker. To it was added pyrrole monomer (which was taken in different moles each time). Further oxidizing agent as well as surfactant was added in the beaker. The various concentrations of the monomer taken for the purpose along with the concentrations of the surfactant as well as that of oxidizing agent are depicted in table given below. Distilled water was added in a slow manner as the reaction is having exothermic nature. This process was accompanied by magnetic type of stirring of vigorous nature so that the pyrrole could be dispersed easily. The reaction was done for a time period consisting of four hours and the temperature maintained during the course of reaction was 25^{o}C. There was a prompt precipitation of particles of black color and these were fine in nature. Once the process of polymerization attained the required time period filtration process was initiated. After the of filtration the obtained precipitate was subject to thorough washing which was done using distilled water as well as ethanol. This process of washing was repeated over and over many times. After this step the synthesized polypyrrole was made to dry in vacuum conditions in an oven. The temperature maintained was 40°C and the drying was done overnight[7-8].

Table 1: Different materials used along with their concentrations for synthesizing polypyrrole

S.No.	Name	Designation	Concentration (M)
1	Pyrrole monomer	mPPy	0.04, 0.08, 0.16, 0.24
2	Ferric chloride	$FeCl_3$	0.04, 0.08, 0.16, 0.24
3	Ammonium persulphate	$(NH_4)_2S_2O_8$	0.2
4	Sodium dodecyl sulphate	$C_{12}H_{25}SO_4Na$	0.044

3.Result and Discussion

3.1-TGA pattern of the PPY-I

In figure-1 the initial degradation is observed from 0^0C to 150^0C. This degradation has its origin because of the loss of water present in the sample. Considering the graph further it is observed that from150^0Cto 250^0C slower degradation occurs. And it represent the thermal stability of compounds moving on when the temperature range of 250^0C to 400^0C is considered, it witnesses a quick degradation and degradation of compounds.

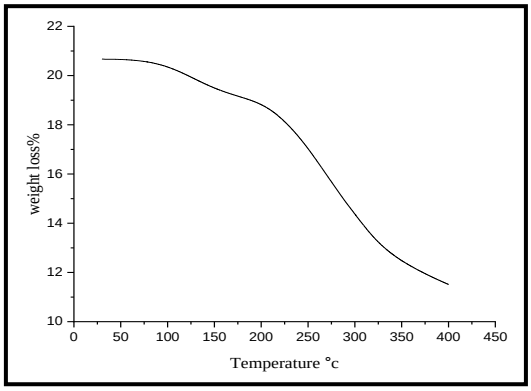

Figure 1: TGA patternof the PPY-I

3.2-TGA pattern of the PPY-II

Figure-2 tells that first degradation happens between the temperature range of 0^0Cto 130^0C. This degradation is happening due to water present in the sample which is lost during this course of temperature. From the temperature 150^0C to 250^0C slower mode of degradation takes place. And it represent the thermal stability of compounds On observing further it is seen that from 250^0C to 400^0C quick degradation takes palce as is observed from the graph. And it represent degradation of compounds.

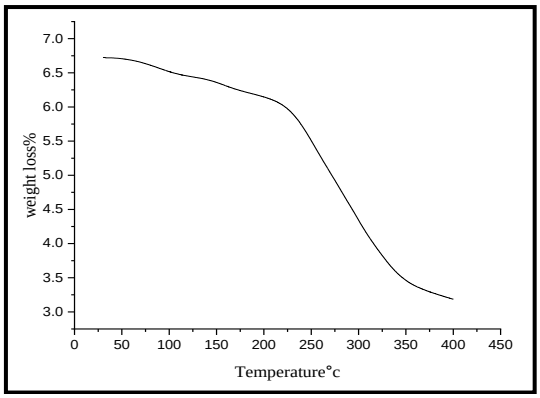

Figure 2: TGA pattern of the PPY-II

3.3-TGA pattern of the PPY-III

Figure -3 reveals that first degradation occurs from 0^0C to 100^0C. This observation is attributed to the fact that water present in the sample is lost. Moving forward from 100^0C to 260^0C slower degradation takes place, as is seen in the graph. And it represent thermal stability of compounds. From the temperature range 250^0C to 400^0C quick degradation is observedand it represent degradation of compounds.

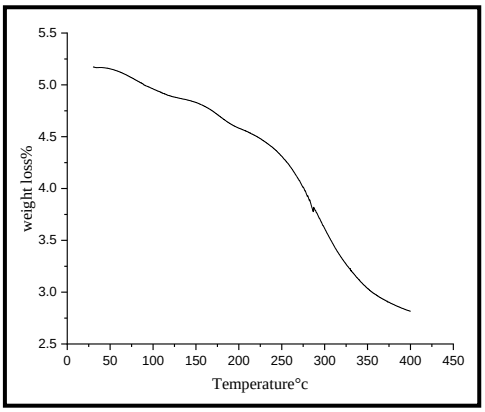

Figure 3: TGA pattern of the PPY-III

3.4-TGA pattern of the PPY-IV

In figure -4, first degradation is seen from 0^0C to 100^0C. It is supposed to take place because of water present in the sample. There after in the temperature range of 100^0C to 260^0C slower degradation is observed. And it represent the thermal stability of polymer Further it can be observed that from 290^0C to 400^0C quick degradation takes place and degradation of polymers .

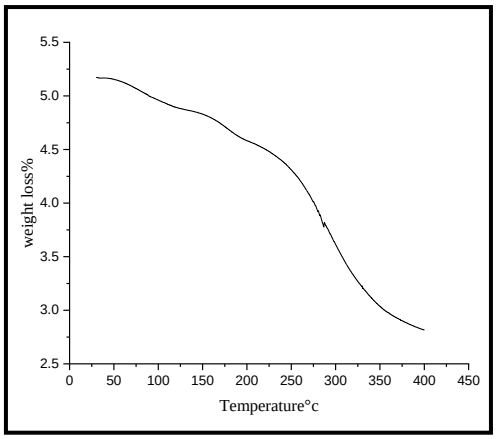

Figure 4: TGA pattern of the PPY-IV

4-Conclusion

The thermogravimetric studies were carried out on the synthesized conducting polymers by change in oxidizing agents. The general trend revealed by this study reflects that the synthesized polymers exhibits a gradual initial loss of smaller molecules as water. On moving ahead in the further temperature ranges it was seen that the degradation was of slow nature. As the studies were carried to higher temperature ranges it became clear that all polymer have adequate range of thermal stability.

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