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Detection the Degradation of PS thin films Containing Triazole Complexes by FTIR Technique

RAGHAD HADDAD[1]*, DINA S. AHMED[2], WEDAD H. AL-DAHHAN[2], AHMED AHMED[3], SALAM MOHAMMED[4] and EMAD YOUSIF[2]

[1]College of Pharmacy, Privat.e Uruk University, Baghdad, Iraq.
[2]Department of Chemistry, College of Science, Al-Nahrain University, Baghdad, Iraq.
[3]Polymer Research Unit, College of Science, Al-Mustansiriyah University, Bagdad, Iraq.
[4]College of Engineering and Architecture, University of Nizwa, Birkat Almouz, 616 Nizwa, Oman.

Abstract

4-amino-5-(pyridyl)-4H-1,2,4-triazole-3-thiol (X) with Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+} and Sn^{2+} has been synthesized also used as PS photostabilizers. In chloroform solvent, these complexes mixed with PSto form modified PS, which involving (0.5%wt)of complexeswere prepared usingcasting method. At room temperature the intensity of light (6.02×10-9Ein Dm^{-3} S^{-1}) and wavelength 365nm with utilized to irradiate polymeric films. PS films irradiationwith UV light led to obvious changes in infrared spectra. The photostabilization activity of these polymeric films was investigated by observation the indices using FTIR spectroscopy.

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Metal complexes;
Photostabilizer.

Introduction

Polymers are organic materials which are synthesized from monomers. Polymers can be classified into synthetic and natural. Synthetic polymers like Polyester, Polyvinyl chloride and Polystyrene[1,2]. The plastics uses in the building applications is public in the improve world because of the low cost and the easiness uses of plastic contrast to the conventional metal, wood, mortar, glass and others. Plastics utilized in other products likefishing gear, marine craft andoutdoor furniture, which are usually used outdoors as well[3]. Using polymers have disadvantages one of these is that polymers degrade when they are appliedin outdoor applications or high temperature conditions. While polymers are utilized in outdoor applications, the environment affected the servicelife negatively. This method is called weathering[4]. The control PS film becomes slightly yellow in color during irradiation. Yellow coloring of PS sample can result from the formation of many different chromophoric groups. It is mostly accepted that acetophenone end group form throughout PSUV

CONTACT Raghad Haddad raghadhaddad89@yahoo.com College of Pharmacy, Uruk University, Baghdad, Iraq.
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irradiation is the most prospective, are accountable for yellowing coloration of the polymer[5]. Polystyrene is a multipurpose polymer that is applied in various applications. Common purpose of PS is hard and clear which is applied inelectronics, laboratory wareand packaging[6]. One of the important PS usesin the produce of cover signal lamps of some automobiles[7]. Photodegradation is the molecule degradation caused by the photon absorption. Specially, those wavelengths found in sunlight, likevisible light, ultraviolet light and infrared radiation, it involves the chemical and physical changes caused by irradiationof polymers with visible light or ultraviolet. Therefore, the chromophoric group existence in the macromolecules is a needed for photochemical reaction initiation[8]. A common photodegradation reaction is oxidation. All synthetic polymers demand stabilization the oppositeinfluences; It became necessary to discovermethods to reduce or inhibit the damage caused by the parameters of environmentlike air, heat and light. That is why the polymers photostability is one of the most important respects for application. The photostabilization of polymers includes the retardation or elimination of photochemical process in polymers and plastics that happenthrough irradiation[9]. Practice views that when the polymer includes a photostabilizer, theoxidation rate is much reduced, stabilizers do not completely inhibit the oxidation butcan reduced it[10-13]. In this work the synthesizing of Zn^{2+}, Cd^{2+}, Sn^{2+}, Ni^{2+} and Cu^{2+} with 4- amino-5-(pyridiyle)-4H 1,2,4 triazol -3- thiol (X) were used for photostabilization of Polystyrene and study the change in FTIR spectrum during irradiation.

Experimental

All chemicalscommercially purchased and used without further purification. The FTIRspectra were listed using FTIR spectrophotometer 8300 Shimadzu in the range of frequency between (4000-400) cm^{-1}.

Synthesis of Metal Complexes

The complexes $Cu(X)_2$, $Zn(X)_2$, $Ni(X)_2$, $Cd(X)_2$ and $Sn(X)_2$ (Figure 1) were synthesized as previously reported[14].

Films Preparation

In chloroform solvent, PS dissolved with metals complexes to form PS films, a micrometer type 2610 A, Germanywas utilized to measure films thickness, and it is about (40 μm). By using evaporation technique the films were prepared at room temperature[15,16].

Accelerated Testing Technique

The wavelength of UV- Light that used for polymeric films irradiationin the range (250-380) nm, the light intensity at 6.2×10^{-9} Ein Dm^{-3} S^{-1}. The polymeric films were fixed analogous to each other and the UV lamp. 10 cm is the distance between the source and polymeric films. The irradiated films were interchanged from time to time to enclose thelight intensity occurrence on eachfilm is the same[17].

Photodegradation Rate of Polymeric Films by Infrared Spectrophotometry

The photodegradation degree of polymeric films was monitored by FTIR spectra in the range (4000-

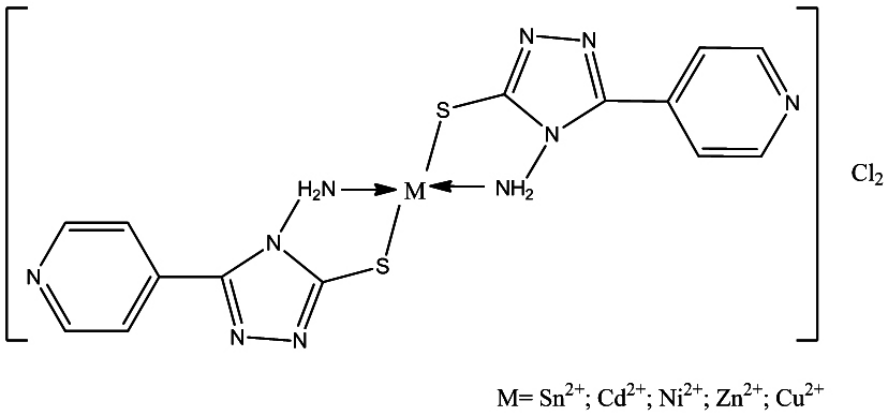

Fig. 1: Structure of $M(X)_2$.

400) cm^{-1}. At 1720 cm^{-1} the carbonyl absorption is appearance. At different times of irradiation the photodegradation progress was observed by the changes in intensity of carbonyl peak; this called the "band index method",[17,21] as equation 1:

$$Is=As/Ar \quad ...(1)$$

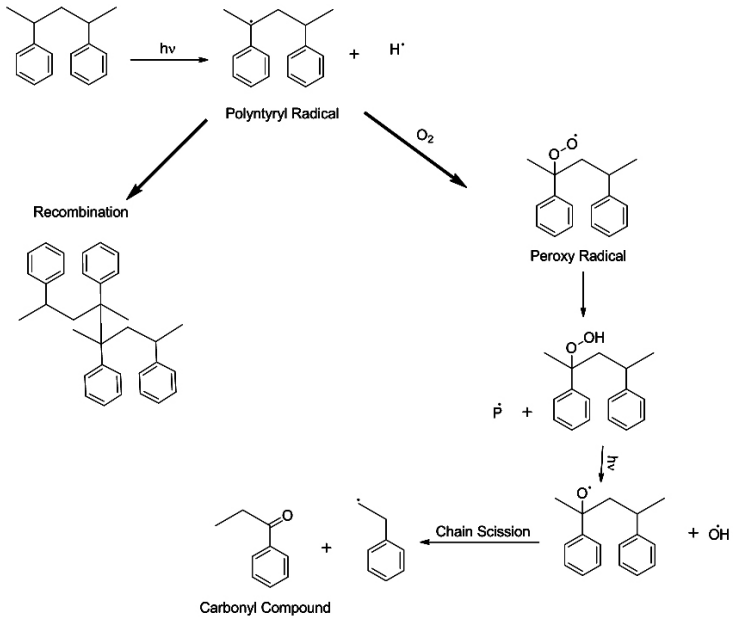

Fig. 2: The general process for photodegradation of polystyrene[18].

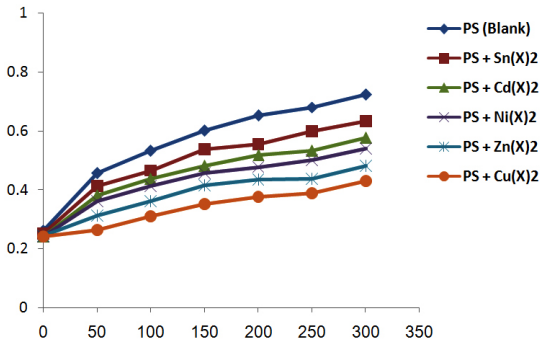

Fig. 3: Change in I_{OH} during irradiation time for PS films.

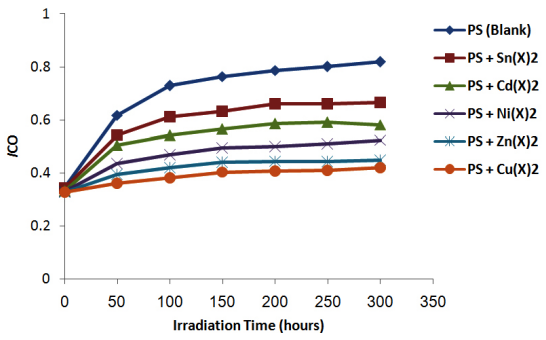

Fig. 4: Change in I_{CO} during irradiation time for PS films.

Results and Discussion

4-amino-5-(pyridyl)-4H-1,2,4-triazole-3-thiol(X) with Ni^{2+}, Cu^{2+}, Zn^{2+}, Cd^{2+} and Sn^{2+} were applied accordingly additives for PS photostabilization. PS films irradiation with wavelength light, λ=365 nm due to obvious changes in their infrared spectra. (Figure 2) explain the photodegradation mechanism of PS in the presence of oxygen.

Ultraviolet radiation has harmful influences on polystyrene that due to chemical changes into polymeric chains. Therefore, the polymeric materials could lose their mechanical properties and be discolored[23]. The photo activity of triazole additives in PS films has been tested and their efficiency in preventing the photooxidation reaction has been examined by spectroscopic methods. Thespectra

of IR recorded during irradiation show increasing in absorbance attributed to formation of oxidized products so the intense bands appearance in the range between (1690-1730) cm^{-1} refers to the carbonyl groups formation are applied to realize the degradation of polymer extension throughout irradiation. A broad band appearance in the range between (3200-3600) cm^{-1} due to hydroxyl group[19]. These absorptions are studied as carbonyl (I_{CO}) and hydroxyl(I_{OH}) indices[20,22]. So, the growth of these indices is the degradation measurement. The presence of $Cu(X)_2$, $Zn(X)_2$, $Ni(X)_2$, $Cd(X)_2$ and $Sn(X)_2$ show lower growth rate of indices against time of irradiation with consideration to the PS without additives (blank).The results confirmed that all these additives are photostabilizer for PS films. However, from the growth rate of carbonyl and hydroxyl indices, the $Cu(X)_2$ represents the most effective photostabilizer, followed by $Zn(X)_2$, $Ni(X)_2$, $Cd(X)_2$ and $Sn(X)_2$ are less active as shown in Figures 3 and 4.

The increases in both I_{CO} and I_{OH} indices can be used as a signal for photodegradation of PS. It must be known that indices does not beginning from zero because some photodegradation occur through PS films preparation.

Conclusion

The PS films photostabilization which containing bis(4-amino-5-(pyridyl)-4H-1,2,4-triazole-3-thiol) have been studied. These additives act effective as photostabilizers for PS films. According to their reduction in indices, the additives take the next arrangement in activity of photostabilization.

$$Cu(X)_2 < Zn(X)_2 < Ni(X)_2 < Cd(X)_2 < Sn(X)_2$$

Increasing activity

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References

1. Hu X., He Q., Lu H., Chen H., Fabrication of gold microelectrodes on polystyrene sheets by UV-directed electroless plating and its application in electrochemical detection, *J. Electroanaly Chem., 638*, 21-27, (2010).
2. Okamura O., Yamauchi E., Shirai M., Photo-cross-linking and de-cross-linking of modified polystyrenes having degradable linkages Reactive Functional, *Polymer, 71*, 480-488, (2011).
3. Sampers J., Polymer Degradation Stabilization, 67, 455-463, (2002).
4. Wypych G., Handbook of material weathering, 4th edn, Chemtec Publishing, Toronto, (2008).
5. Yousif E., Aliwi S., Ameer A., Jaleel R., Improved photostability of PVC films in the presence of 2-thioacetic acid-5-phenyl-1,3,4-oxadiazole complexes, *Turk J. Chem., 33*, 399-410, (2009).
6. Meenakshi P., Noorjahan E., Rajini R., Venkateswarlu U., Crose S., Mechanical and microstructure studies on the modification of CA film by blending with Polystyrene, *Indian Academy of Sciences, 25*, 25-29, (2002).
7. Safy Eldin M., El-laithy A. Photooxidative degradation of polystyrene of cover signals lamp of some automobile, *J. of applied polymer science, 55*, 47-54, (1994).
8. Schnabel W., Polymer Degradation: Principle and Practical Applications, Chapter 14, *Hanser Int, München*, (1981).
9. Ahmed D.S., El-Hiti G.A., Hameed A.S., Yousif E., Ahmed A. New tetra-Schiff bases as efficient photostabilizers for poly(vinyl chloride), *Molecules, 22*, 1506, (2017).
10. Ahmed D.S., El-Hiti G.A., Hameed A.S., Yousif E., Ahmed A. Polyphosphates as inhibitors for poly(vinylChloride) photodegradation, *Molecules, 2*2, 1849, (2017).
11. Yousif E., Salimon J., Salih N., New stabilizer for polystyrene based on 2-N-Salicylidene-5-(substituted)-1,3,4-thiadiazole compoundes, *J. of Saudi Chemical Society, 16*, 299-306, (2011).
12. Ghazi D., El-Hiti G.A., YousifE., Ahmed, D.S., Alotaibi, M.H. The Effect of Ultraviolet Irradiation on the Physicochemical Properties of Poly(vinyl Chloride) Films Containing Organotin(IV) Complexes as Photostabilizers,

Molecules, 23, 254, (2018).

13. Yousif E. and Haddad R., Photodegradation and photostabilization of polymers, especially polystyrene: review, Springer Plus, *2*, 398-460, (2013).
14. Haddad R., Yousif E. and Ahmed A., Synthesis and characterization of transition metal complexes of 4-Amino-5-pyridyl-4H-1,2,4-triazole-3-thiol, Springer Plus, *2*, 510-516, (2013).
15. AliM., El-Hiti G., Yousif E., Photostabilizing efficiency of poly(vinyl chloride) in the presence of organotin(IV) complexes as photostabilizers, *Molecules, 21*, 9, (2016).
16. Yousif E., Salimon J., Salih N., New stabilizer for polystyrene based on 2-Thioacetic Acid Benzothiazol complexes, *J. of applied polymer Science, 125*, 1922-1927, (2012).
17. Yousif E., Salimon J., Salih N., Improvement of photostabilization of PVC in the presence of thioacitic acidbenzothiazole complexes, *The Malaysian J. of Analytical Sciences, 15*, 81-92, (2011).
18. Yousif E., Salimon J., Salih N., New stabilizer for polystyrene based on 2-N-Salicylidene-5-(substituted)-1,3,4-thiadiazole compoundes, *J. of Saudi Chemical Society, 16*(3), 299-306, (2011).
19. Rabek J. and Sanetra J., Macromolecules, Springer Berlin Heidelberg, *19*, pp. 1679, (1986).
20. Yousif E., El-Hiti G., Hussain Z., Altaie A., Viscoelastic, spectroscopic and microscopic study of the photo irradiation effect on the stability of PVC in the presence of sulfamethoxazole Schiff's bases, *Polymers, 7*, 2190-2204, (2015).
21. Shaalan N., Laftah N., El-Hiti G.A., Alotaibi M.H., Muslih R.,Ahmed D.S., Yousif, E. Poly(vinyl Chloride) photostabilization in the presence of schiff bases containing a thiadiazole moiety. *Molecules, 23*, 913, (2018).
22. Ahmed D.S.,El-Hiti G.A.,Hashim H., Noaman R.,Hameed A.S., Yousif, E. Physical and morphological properties of poly(vinyl chloride) films upon irradiation in the presence of tetra schiff bases as photostabilizers. *Arab J. Phys. Chem.5*, (2018).
23. Ali G.Q., El-Hiti G.A.,Tomi I.H.R., Haddad R., Al-Qaisi A.J., Yousif E. Photostability and Performance of Polystyrene Films Containing 1,2,4-Triazole-3-thiol Ring System Schiff Bases. *Molecules, 21*, 1699, (2016). doi:10.3390/molecules21121699.