

Formation of Conjugated Double Bonds to Induce Polystyrene Conductivity by using Different Concentrations of Methoxo-Oxo Bis (8-Quinolyloxo) Vanadium (V)

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Abstract

The effect of different concentrations of additive compound methoxo–oxo bis (8-quinolyloxo) vanadium (v) on formation of conjugated double bonds as part of photo transformation of polystyrene has been investigated. The UV-Vis spectrophotometry has been used in this work. The results are show that additive concentrations applied increase the formation of conjugated double bond as compared with polystyrene. In this study methoxo – oxo bis (8-quinolyloxo) vanadium (v) indicates great activity to enhance the conductivity of polystyrene by formation of conjugated double bonds.

Key words: conjugated double bonds, photo degradation, and polystyrene.

الخلاصة

تأثير استخدام تراكيز مختلفه من المركب ميثوكسو أوكسو ثنائي (8-كوينوليوكسو) فناديوم (V) على تكوين أواصر مزدوجه متعاقبه كجزء من التحولات الضوئيه للبولي ستايرين، تم متابعتها بأستخدام مطيافية الاشعه فوق البنفسجيه- المرئيه. بينت النتائج زياده أمتصاصية الاواصر المزدوجه المتعاقبه بوجود تراكيز مختلفه من المركب مقارنة بالبولي ستايرين لوحده، حيث بين المركب فعاليه جوده لحت خاصية التوصيليه للبولي ستايرين بسبب تكوين الاواصر المزدوجه المتعاقبه. الكلمات المفتاحيه: الاواصر المزدوجه المتعاقبه، التجزئه الضوئيه، البولي ستايرين.

Introduction

The possibility to produce conducting polymers (Chiang *et al.*, 1977) is rapidly gaining attraction in new applications alongside with increasingly processable material with better electrical and physical properties and lower cost. This concept can be achieved by modifying specific polymer to produce polyene system by adding chemical compounds which can be conduct either as sensitizer where the process involves gaining energy without decomposition of sensitizer molecules or as photoinitiator.

Many chemical complexes such as ketones, quinone, peroxide and many inorganic complexes are initiators of different reactions occurring in organic compounds (Yamashita *et al.*, 1998; Shield, *et al.*,1998; Jiang *et al.*, 1998; Oatsis Jr *et al.*, 1998; Rajan *et al.*, 2012) such as polymerization, degradation and chemical modification, hence they can absorb incident light up to 380 nm, leads to cleavage into free radicals, and that cause photo chemical transformations in polymer degradation and other transformations (Al Ani Khalid *et al.*, 2015).

Nowadays, there are many applications based on conducting polymers such as photovoltaic cells (Sakai *et al.*, 2010, Szmytkowski, 2010, and Cai *et al.*, 2010), organic transistors (Chan *et al.*, 2010; Chao *et al.*, 2010), light emitting diodes (Chong *et al.*, 2009), printing electronic circuits, chemical and biosensor, super capacitors, and radar-absorptive coating.

The aim of this work was to find out how the formation and concentration of conjugated double bonds that forms on photo-oxidative degradation of polystyrene (PS) by methoxy-oxo bis (8-quinolyloxo) Vanadium (V), VOQ_2OCH_3 could affect the photochemical transformations of polystyrene and its conductivity.

Experimental

Materials

Commercial polystyrene with average viscosity molecular weight $105200 \text{ gm.mole}^{-1}$ was used after purification.

Methoxy-oxo bis (8-quinolyloxo) vanadium (v) was prepared as described by Blair, Pantony and Minkooff (Blair *et al.*, 1973).

Different concentrations of additive in chloroform solution added to polystyrene in chloroform solution, and thin polystyrene films with and without additive obtained by casting these solutions into glass plates, then dried after evaporation at room temperature for 24 hours.

Irradiation

Polystyrene films exposed to irradiation using Q.U.V accelerated weathering tester (Q. Panel Company, USA) between 0-200 hours at 45°C in air atmosphere with highest emitted intensity at wavelength $\lambda = 313 \text{ nm}$.

Analysis

The formation of double bonds was observed in the UV-Vis absorption spectra obtained by using Centra 5 GBC Scientific Equipment Spectrophotometer.

Results and Discussion

Photo-oxidative degradation of polystyrene by using organic or inorganic compounds such as VOQ_2OCH_3 involve free radical reactions in the presence of oxygen which lead to random chain scission and crosslink and formed many sites of free radicals (Madras G, *et.al.*, 1997, Aliwi S M, *et.al.*, 2001) contains free electrons with double bond conjugated system, as in figure 1, where macroallyl radicals formed at the first step of degradation, followed by polyene radicals with relatively high thermal stability because of delocalisation of π -electrons (Kuzina SI, *et.al.*, 1993).

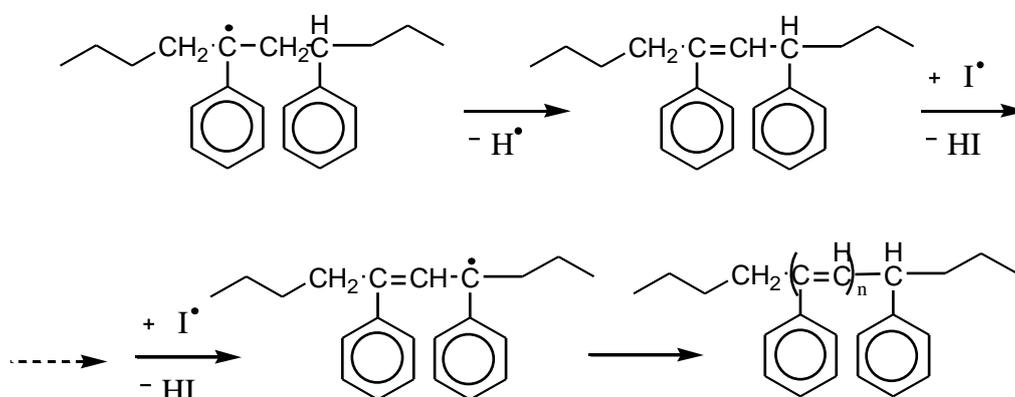


Figure 1: Mechanism of conjugated double bonds formation

Double bonds in conjugation behave differently than isolated double bonds with conjugated double bonds resonance structures can be drawn as in figure 2.



Figure 2: conjugated double bonds resonance structures

Conjugated double bonds made the absorbance shift to longer wavelength induced polystyrene sensitivity to visible light. In this case there are different wave length bands that can be attributed number of conjugated double bonds (Geuskens *et al.*, 1978, Millan *et al.*, 2005, Leticia *et al.*, 2013).

The change of absorbance is at 312, 328 and 368 nm for the polyene number $n=2, 3$ and 4 , these changes are shown in figures 3, 4, and 5 respectively. Double bonds formation at wavelength 312 nm can be seen, it increases with increase of VOQ_2OCH_3 concentration, but the changes with higher wavelength, 328 and 368nm are less effective, that means the number of conjugated double bond with $n=2$ is more dominate and form rapidly, while conjugated double bonds with $n=3$ and 4 are formed and increased slowly, this could be due to action of free radical scavenger by radicals of initiator (Kaczmarek *et al.*, 2000).

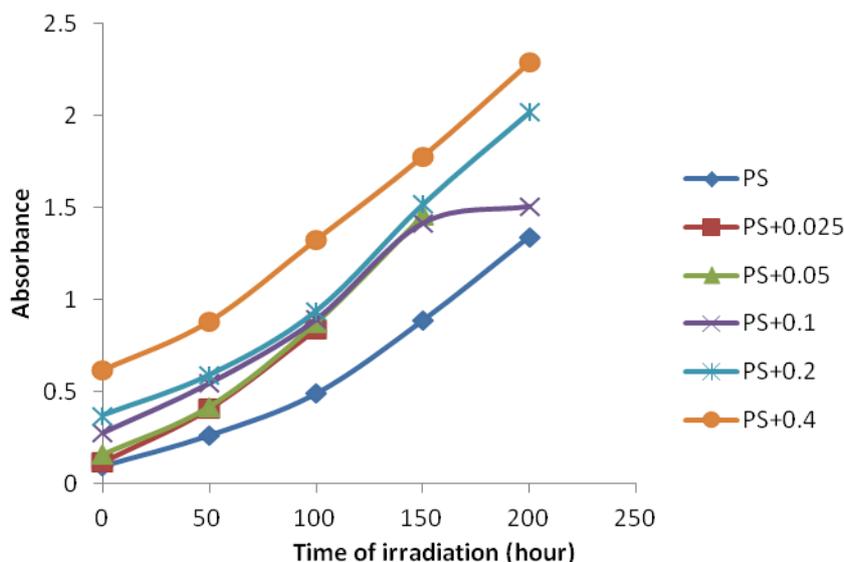


Figure 3: Changes of absorbance due to conjugated double bonds $n=2$ at 312 nm in PS and PS with different concentration of VOQ_2OCH_3 .

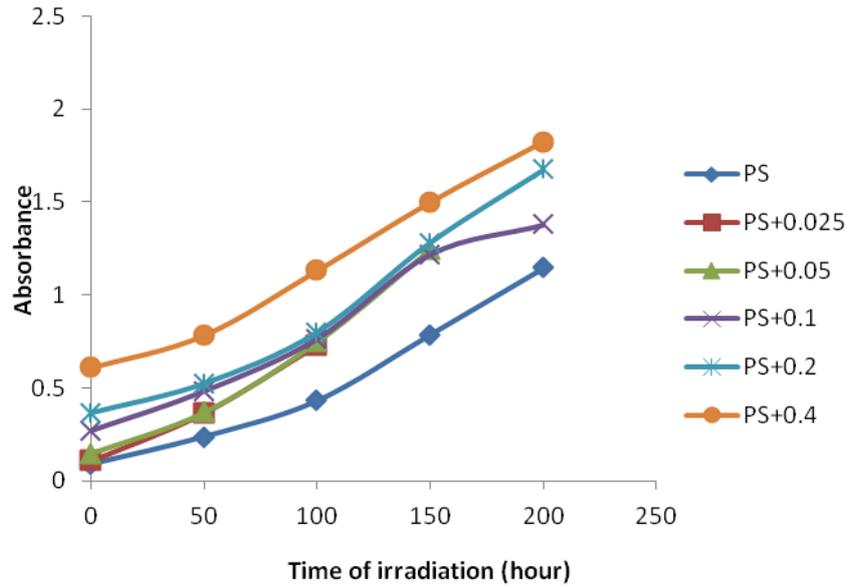


Figure 4: Changes of absorbance due to conjugated double bonds n=3 at 328nm in PS and PS with different concentration of VOQ₂OCH₃.

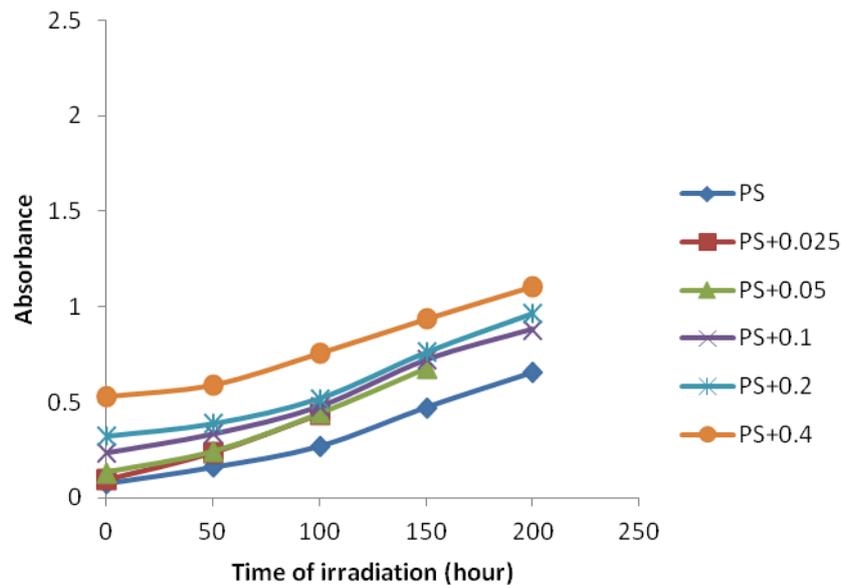


Figure 5: Changes of absorbance due to conjugated double bonds n=4 at 368nm in PS and PS with different concentration of VOQ₂OCH₃.

Conclusions

There is competitive reactions occur in photo-oxidation degradation of polystyrene, one of them is double bond formation which is increased with additive concentration increase and decrease with wavelength increase because of chain scission process, and gives different size of conjugated double bonds chains where number of conjugated double bond, n=2, 3 and 4, inside polymer layers which gives many abilities of conductivity properties that could be used in different application of conductive polymers.

We highly believe that the facts demonstrated here would offer a good possibility for development of applications in advanced materials and devices in the desired purposes.

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