UV-Irradiation Effect on PC/DOP Composite in the C=C Region

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Abstract:

In this research we study the effect of UV radiation on pure PC samples and doped samples with plasticizer (DOP) for different exposure times (6, 12, 18, 24h). The study have been made on the change in the IR spectra causes by the UV radiation on both kinds of samples, besides the morphology changes were also studied by the optical microscope. From the results we conclude that the increasing of exposure causes the elaboration of CO_2 and C_2 gases.

تأثير الأشعة فوق البنفسجية على المتراكب PC/DOP ضمن المنطقة تحت الحمراء

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الخلاصة:

تم في هذا البحث دراسة تأثير الأشعة فوق البنفسجية على عينات البولي كربونات النقية والمطعمة بالملدن من نوع DOP ولفترات تشعيع مختلفة (6, 12, 18 and 24h). درست التغيرات الحاصلة على طيف الأشعة تحت الحمراء بتأثير الإشعاع على العينات النقية والمطعمة. وكذلك التغيرات الحاصلة على سطح العينات بواسطة المجهر الضوئي. واستنتج من النتائج أن زيادة وقت التعريض سيؤدي إلى تحرير غازي CO_2و C_2 وبالتالي تغير طيف الامتصاص في مدى محدد من الأشعة تحت الحمراء ومعالم سطح العينات.

Introduction:

The photo-degradation and photo-oxidation of bisphenol-A polycarbonate has attracted a considerable degree of interest, which reflects the commercial importance of this polymer. Particular emphasis has been placed by Clark [1], Clark and Munro [2,3] on the changes of PC surface exposed to UV and artificial weathering. They showed the major contribution arising from photo-oxidation, involving the gem dimethyl and phenyl moities, their results represent the predominate mechanism, as the photo-oxidation rather than photo-Fries rearrangement. [4]

Recently, Adams and Garton [5] showed that the dominate photo-reactions were chain scissions rather than photo-Fries rearrangement and that was by exposing samples of PC to far UV radiation from a deuterium lamp in air. They also and by exposing the same samples to the same source but in vacuum [6], detected the photo-Fries reaction products such as substituted benzophenones. However main chain scission reaction appears to dominate the degradation mechanism.

More recently Rivaton [7] showed the maximum absorption for the irradiated samples of PC in the carbonyl and hydroxyl regions of the IR were assigned, and the corresponding photoproducts were identified. This study showed that the photochemical evaluation of PC mainly involves two successive photo-Fries rearrangement a photo-induced oxidation on the side–chain and a phenyl ring oxidation

Experimental Part :

Material

The solute was highly pure PC of ICI. The solvent used was methylene chlorine supplied by BDH of purity 99.99%. Di Octyle Phthalate (DOP) was used as plasticizer for fixed weight (0.1g). PC of different masses (0.2, 0.4, 0.6 and 0.8g) was dissolved in 10ml of CH_2Cl_2, (0.1g) of DOP was added to the above solution, then this solution was handily shacked for half an hour or more to achieve a homogeneous content. The solution was then transferred to a clean petridish of 6cm in diameter placed on platform leveled and covered to dry for 24h. The dried film was placed off the petridish and kept in a discrete before irradiation process was carried out.

Photo-Irradiation:

Each sample was irradiated for (6, 12, 18 and 24h) to an intense UV-light generated by a high pressure Hg-lamp (300W) OHD type (main emission at 254, 290 and 365nm). The irradiation was carried out using a system specially erected for this purpose.

Measurement :

Infrared spectra for the unirradiated and irradiated samples were recorded by Philips/P4/9700IR spectrophotometer. The morphology changes were studied by the Olympus BH-2 optical microscopic.

Results, Discussion and Conclusion:

The absorption of hydrocarbon molecules is expected to have three distinguished regions. In the first which localized between (1400-1800 nm) is the stretching possibility of C=C and or C-O absorption peaks. Increasing the incident wavelength yield a second peaks corresponding to C-H stretching. The O-H stretching which identified by the third peaks could be found in the absorption band located at a wavelength greater than 3400nm [9].

In the light of the above information the pure PC molecular structure accordingly in the region of short wavelength and or the second region corresponding to the absorption C=C or C-H. The solid curves presented at figures (1-4) reflected two major peaks for C=C regions; around (1570-1700 nm). However the second peak seems to be enhanced more when the DOP concentration is relatively high though its reaches to a maximum value at certain DOP concentration (≈20%) similarly the higher wavelength absorption also reflected a maximum sensitivity at (20%) DOP concentration.

Irradiation of the composite samples with 6h-exposure time reduces the absorption capability at ≈1700nm and this reduction is more at 20% DOP concentration (Figure 1-4). Longer irradiation times (12,18 and 24h) give unoscillatory; where discussed by Gordan model [10] responses results can only expected in the light of kinking responses where the absorption cross-section alternated to a certain class of responsibility. In this model a periodic relativistic potential well of variable amplitude where suggested due to the rotation of the polarization dipoles. The influence of this rotation changes the optical absorption band to reflect at least two-oscillation time dependary. The phonon concentration of this interaction is again a highly depended on the exposure time. This oscillatory response is also observed at shorter wavelength thus its seems to be in the reverse direction, results gives another support to the conclusion stated above.

Morphology:

Irradiation of PC pure samples to UV light for different exposure times showed sequential changes. In the first duration time CO_2 and C_2 gases which was elaborated due to the chain scission enlarged the microphones (at Figure 5a) to a bigger size (Figure 5b). Further exposure exploding these bubbles and forming a craze marks, Figure (5c), which eventually tends to well defined cracks, Figure 6d. Blending the PC with DOP increases the tendency of craze and crack can be seen in (Figure 6a-d).

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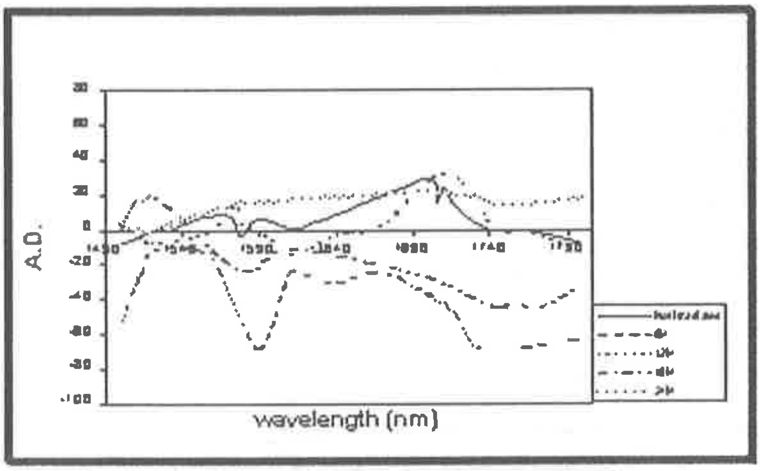


Figure (1) Shows the C=C of 33% dope concentration.

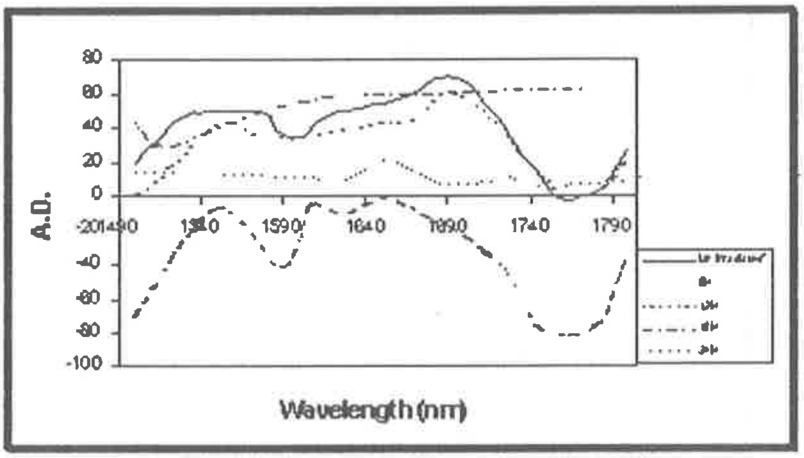


Figure (2) Shows the C=C of 20% dope concentration.

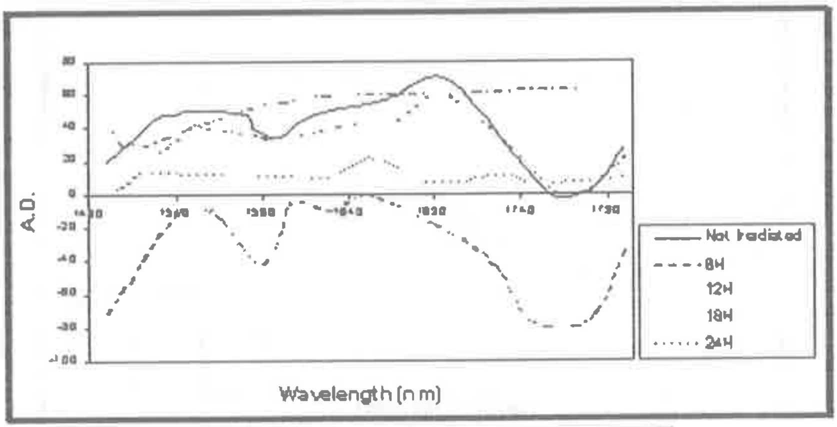


Figure (3) Shows the C=C of 14.3% dope concentration.

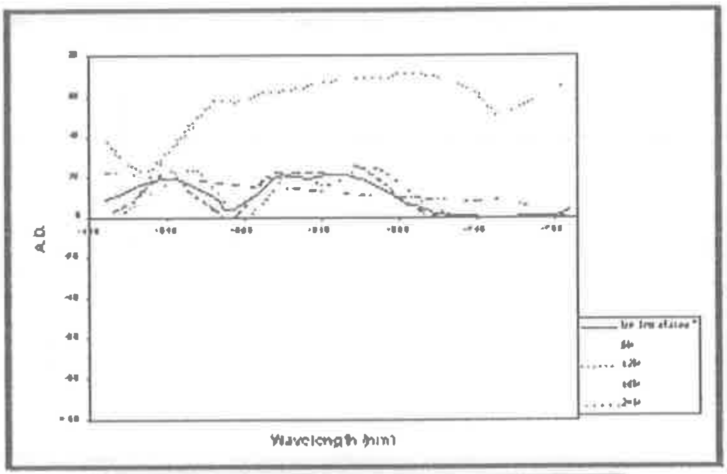
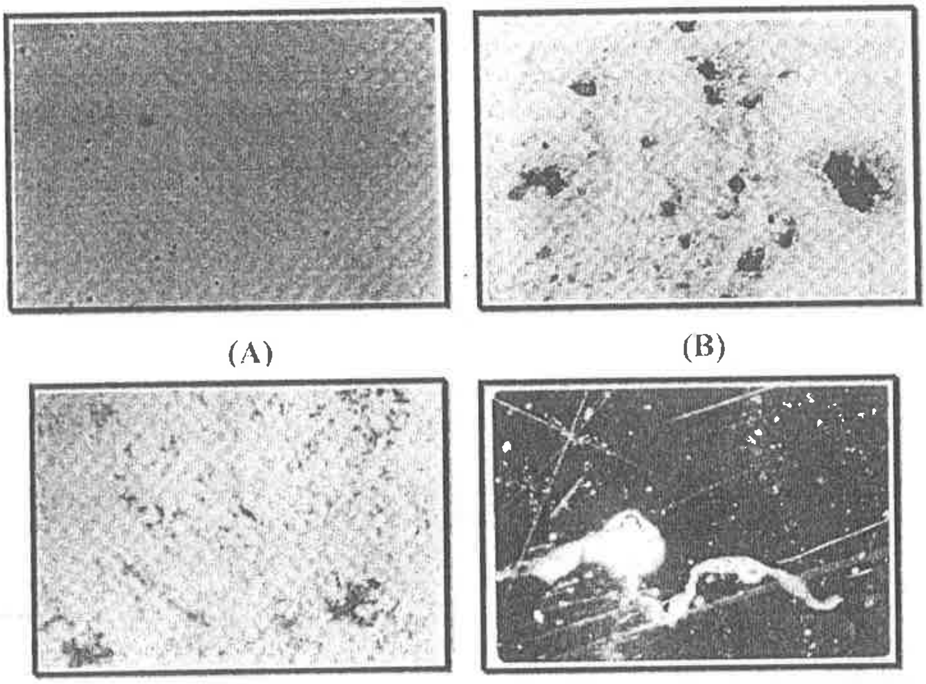


Figure (4) Shows the C=C of 11.1% dope concentration.



(A) (B)

(C) (D)

Figure (5) Optical micrographs for pure PC samples show crazing effect due to UV degradation:
(A) unexposed, (B) exposed for 6h, (C) exposed for 18h and finally, (D) exposed for 24h.

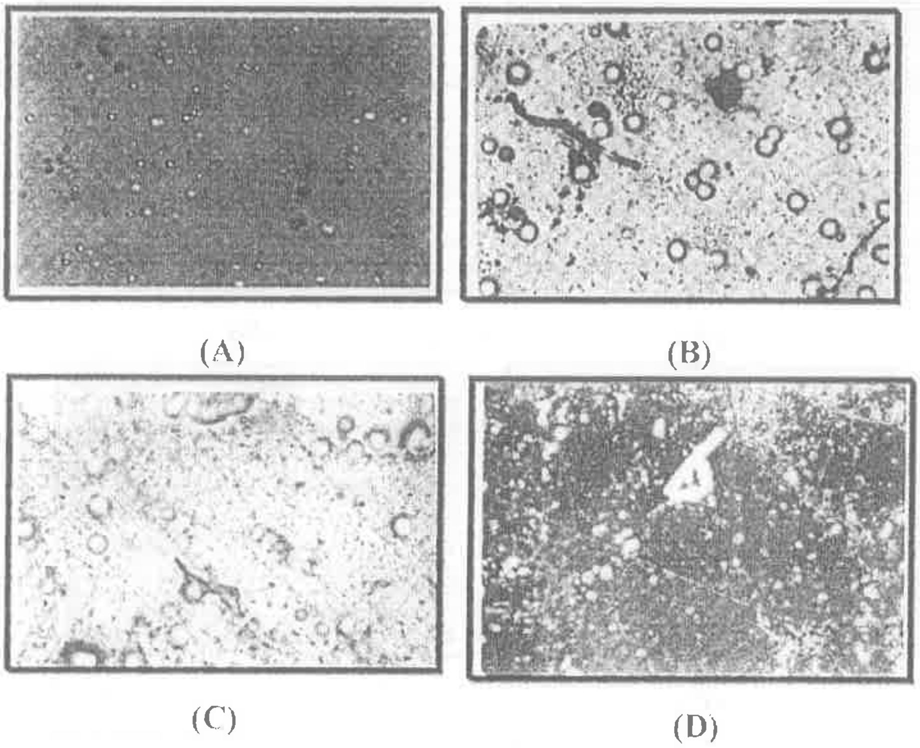


Figure (6) Optical micrographs for doped PC samples with DOP show crazing effect due to UV degradation:
(A) unexposed, (B) exposed for 6h, (C) exposed for 18h and finally, (D) exposed for 24h.