

Study of Photo/Thermal/Oxidative degradation of Polycarbonate Using UV/Py-GC/MS

[Background] Although Polycarbonate (PC) is known to degrade when exposed to UV radiation, the degradation mechanism has not been unequivocally elucidated. The photo/thermal/oxidative degradation of PC was examined using a new analytical technique (Ultraviolet irradiation/pyrolysis (UV/Py)-GC/MS¹⁾).

[Experimental] A UV irradiator, UV-1045E, with a deuterium lamp was used. The sample temperature during UV irradiation was 100°C and the UV irradiation of the sample was performed, in air, for 1 hour. The sample temperature was chosen in order to minimize the thermal degradation of the PC. Thus, changes in the PC can be attributed solely to photo degradation. When the irradiation was finished, the air in the system was purged using helium (He). The volatiles formed during irradiation were then analyzed (Fig 2). The irradiated PC was then analyzed using reactive pyrolysis. Tetramethyl ammonium hydroxide (TMAH) served as the reagent.

[Results] Fig. 1 shows illustrates the expected degradation reactions of PC. It has been reported that scission of the PC polymer main chain at the carbonate bond and the formation of a branched structure through rearrangement are the major degradation pathways²⁾. Therefore, the monomer, bisphenol A (bisA), should be the primary volatile degradation product and the degraded polymer should have branched structures. Fig. 2, shows that the intensity of BisA peak increases by a factor of 10 when PC is irradiated. This indicates that the scission of carbonate bonds in the polymer chain occurred repeatedly. Fig. 3 shows the Rx/PY results on the degraded polymer. Without UV irradiation, peak A¹⁾, known to be a branched structure, was barely visible, on the other hand after UV irradiation, peak A is easily observed. This simple experiment shows the value of UV/Py-GC. The identification of the PC degradation products and the analysis of the irradiated PC support degradation studies published by others.

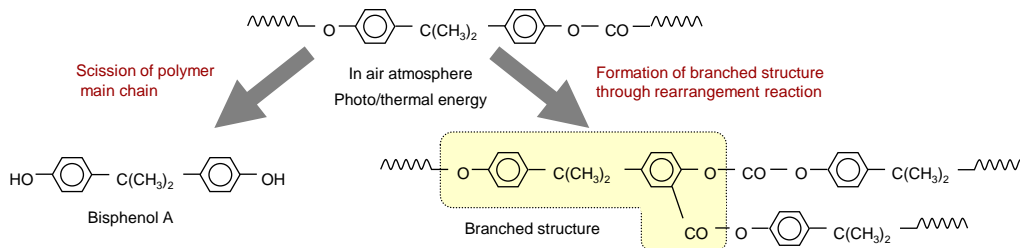


Fig. 1 Expected photo/thermal/oxidative degradation reactions of PC

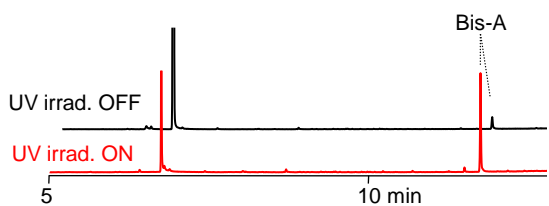


Fig. 2 Chromatograms of volatiles released from PC
 Column: UA⁺-1(L 30 m, id. 0.25 mm, df 0.25 μm), Flow rate: 1 ml/min,
 Split ratio: 1/10, Sample: ca.15 μg (thin film), GC temp.: 40 - 300°C
 (20°C/min), Thermal desorption (TD) temp.: 100 - 350°C (20°C/min)

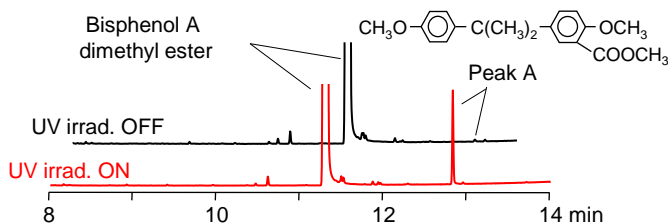


Fig. 3 Pyrograms obtained by reactive pyrolysis of the degraded PC
 Py furnace temp.: 400°C, Reagent: TMAH (25 wt.% in methanol, 3 μL)
 Split ratio: 1/50, other conditions identical to those in Fig. 2.

References: 1) C.Watanabe et al., Polymer Degradation and Stability, 94,1467-1472,2009 (2) K. Oba et al., Macromolecules, 33, 8173-8183, 2000

Keyword : Polycarbonate, Photo/thermal/oxidative degradation, Bisphenol A, Weatherability test

Applications : Photo/thermal/oxidative degradation tests

Related technical notes : PYA2-001E, PYA5-001E

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R&D and manufactured by :
Frontier Laboratories Ltd.

1-8-14 Saikon, Koriyama,
 Fukushima 963-8862 JAPAN
 Phone: (81)24-935-5100 Fax: (81)24-935-5102
<http://www.frontier-lab.com/>

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Scientific Instruments Manufacturer GmbH
 Im Erlengrund 21-23
 D-46149 Oberhausen
 Phone: +49-208-941078-0 Fax: +49-208-941078-88
<http://www.sim-gmbh.de> info@sim-gmbh.de