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Chemical Modification and Functionalisation of Poly(ethylene terephthalate) Fiber

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: (PET)
 . PET COOH 가 가 FT - IR XPS COOH 가 XPS
 PET COOH 가 12 가 .
 PET PET ,
 PET COOH 가 PET
 30 99% 75%
 PET 가 가 .

ABSTRACT : Poly(ethylene terephthalate)(PET) fibers were modified by deep UV irradiation which was produced by a low pressure mercury lamp. FT - IR and XPS analyses were used to elucidate the surface chemical composition of PET fibers treated with UV. Relative O_{1s} intensity increased considerably and it was found that oxygen was incorporated in the form of COO on the fiber surface. FT - IR and XPS analyses proved the existence of carboxylic groups on the surfaces and the adsorption test of cationic compound further supported these results. The concentration of carboxylic acid group on the surface increased remarkably with increasing irradiation time. XPS analysis and adsorption experiments proved that the surface structure of the UV - irradiated PET fibers were stable for 12 months. Antibacterial property and the deodorization rate of UV - irradiated PET fibers adsorbed with the berberine compound were investigated. Reduction rates of bacteria increased by about 21 to 99% compared to unradiated PET fiber. Deodorization rates of 23% for unradiated PET fiber increased to about 75% for 30 min irradiated samples.

Keywords : PET fiber, UV irradiation, XPS, antibacterial property, deodorization.

(PET)
가
가
PET
가
가

PET
가

PET
1-7

가가

가

PET

가

PET

8 - 12

가 가
가

PET

가

FT - IR XPS

glow

13 - 15

가

PET

XPS

가

5,16

PET

가

가

UV - C

KS K 0905

PET

가

100

5

40

가

berberine

70 -

가

80 mesh

petroleum ether benzene

ethanol, methanol, acetone berberine

, sodium bicarbonate acetic acid

pH

17 - 19

1

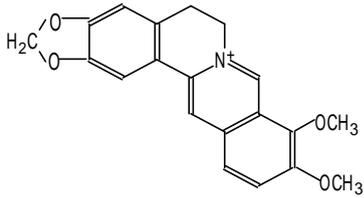


Figure 1. Structure of berberine.

lamp (SUH - 40UH, () SEN ,)
184.9 nm 253.7 nm

PET
desiccator
Berberine . 70 - 80 mesh
100 g 24 ether
(ethanol, methanol, acetic acid, acetone)
0.5 L 가 3 가 ,
ether benzene

Figure 1 berberine
Berberine .
berberine 3%(o.w.f.) ,
1:80, 100 , 100
PET acetone
FT-IR PET
FT - IR (Spectrum
2000 FT - IR Spectrometer, Perkin Elmer, U.S.A)
ATR
10, 20, 30 가
PET

berberine KBr
XPS . PET
LAD MK II, V.G. Scientific LTD, England)
10, 20, 30 PET
10⁻⁹ torr 50°
30 PET
12 XPS
PET .
AATCC 100 Bioassay test
staphylococcus aureus

berberine PET
berberine PET
10 cm x 10 cm
30, 60, 90, 120
가 5, 10, 15
가 .

PET FT-IR .
PET FT -
IR FT - IR
ATR PET
1.5 cm 10, 20, 30
FT - IR Figure
2 . Figure 2
(A) OH
3700 cm⁻¹ PET
(COO) 1720 cm⁻¹
880 cm⁻¹ 가 700 -
3700 cm⁻¹ (B), (C) (D)
880 cm⁻¹ 가 700 -
가 1720 cm⁻¹

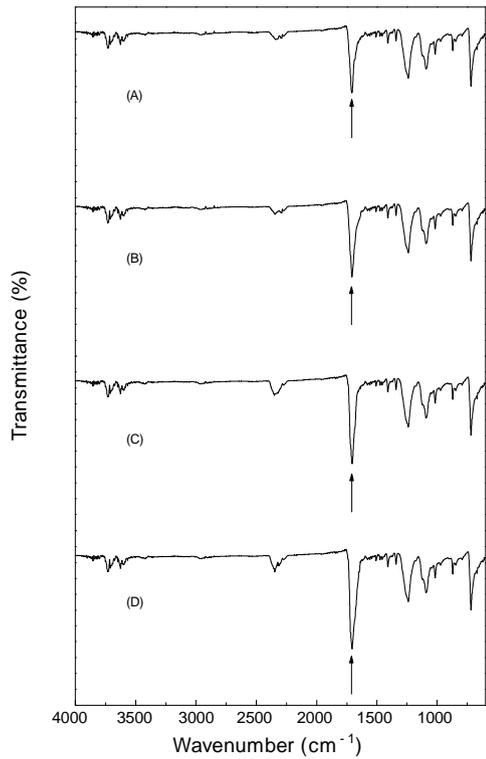


Figure 2. FT-IR spectra of UV-irradiated PET measured by FTIR - ATR (ZnSe) : (A) 0 min, (B) 10 min, (C) 20 min, and (D) 30 min.

가 가

OH

PET 가 COOH

OH 가 3700 cm⁻¹ 가

OH 가

가 1-3

PET C-O (351.5 kJ/mol)

C-H (413.4 kJ/mol) 253.7

nm (472 kJ/mol) 184.9 nm (647 kJ/mol)

C=O 1720 cm⁻¹ 가

23,24 Day

PET -COOCH₂CH₂-

-COOH -COOCH=CH₂ 가

C-H 가 가

가

COOH

가 가

-COOCH₂CH₂

C-H 가 COOH 가 가

PET

COOH 가 FT-IR

PET XPS

PET

1.5 cm

10, 20, 30

10⁻⁹ torr

XPS Figure 3 Figure

3 0-1400 eV

C, H, O

PET XPS 1s,

2s, 2p 가 1s

가 285 eV C_{1s}

532 eV O_{1s} 가

(A)

(B, C, D) C_{1s} O_{1s}

C, H, O

C_{1s} O_{1s}

Table 1

Table 1 PET 가

O_{1s} 가 가 30

O_{1s} 가 7% 가

PET

가 가

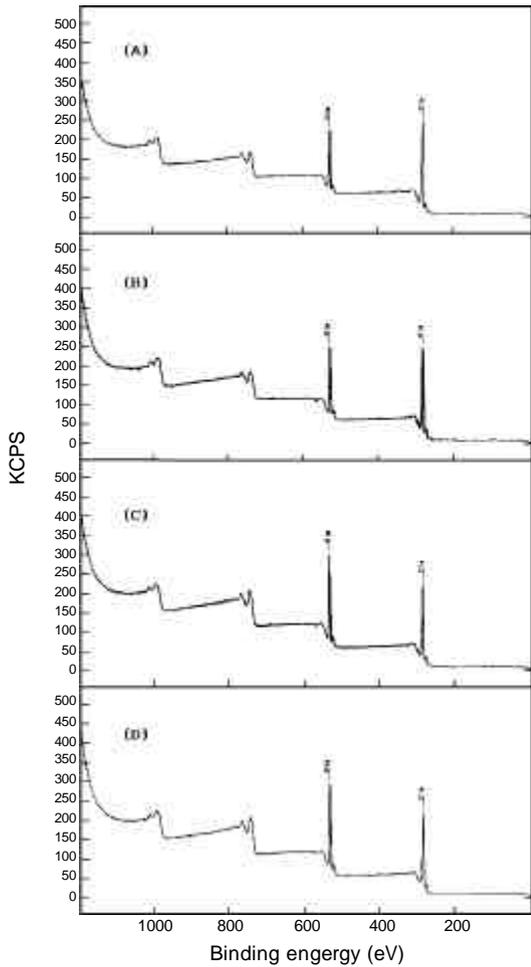


Figure 3. XPS spectra of UV - irradiated PET : (A) 0 min, (B) 10 min, (C) 20 min, and (D) 30 min.

Table 1. Relative Intensities of C_{1s} and O_{1s} in wide Scanning XPS Analysis of UV- Irradiated PET Fibers

chemical composition	UV irradiation time (min)			
	0	10	20	30
O_{1s}	23.76	24.29	30.06	31.49
C_{1s}	74.41	73.71	67.85	67.16

FT - IR

COOH

XPS

shift

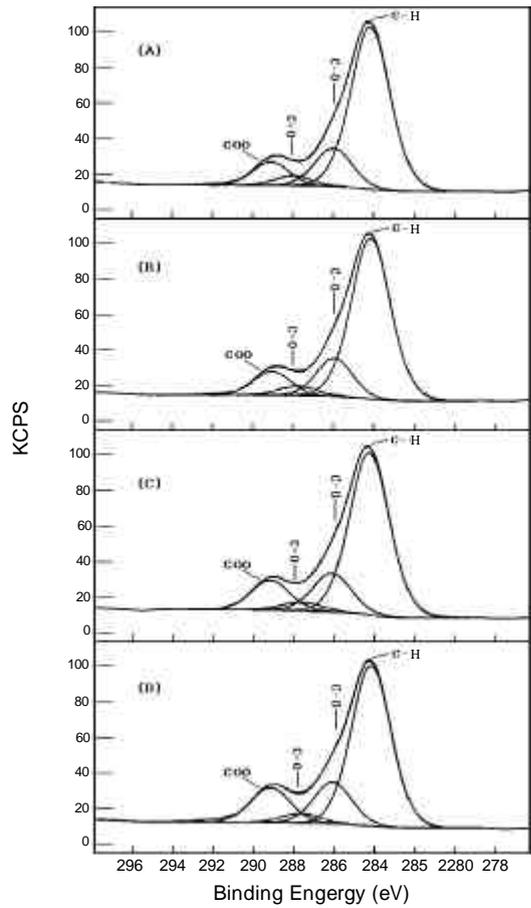


Figure 4. Curve fitting of C_{1s} spectra of UV - irradiated PET: (A) 0 min, (B) 10 min, (C) 20 min, and (D) 30 min.

IR

C - H, COO

trum 4

trum . ESCA , 가 가

가 . FT -

C_{1s}

Figure 4 spectrum

. Figure 4

spec -

spec -

가 shift

289.5 eV

COO

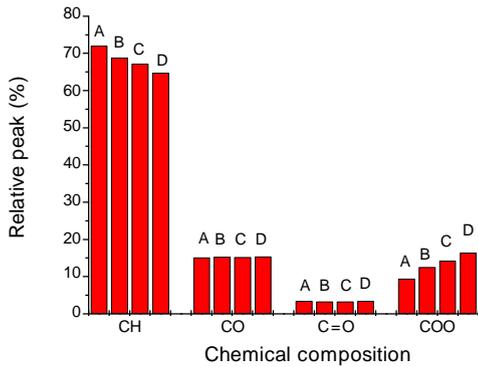


Figure 5. Wave separation of C_{1s} spectra of UV-irradiated PET fibers : (A) 0 min, (B) 10 min, (C) 20 min, and (D) 30 min.

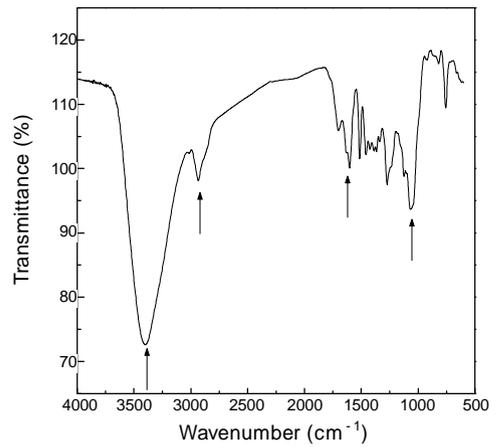


Figure 6. FT - IR spectrum of berberine.

287.5 eV formyl 가
 C=O , 286.2 eV
 C-O , 284.2 eV
 C-H

Figure 4
 289.5 eV COO 가 가

Figure 5
 가 C-H
 C=O C-O 가
 C=O

CHO 가
 , C-O
 OH 가
 C-H COO
 가 C-H
 COOH 가

-COOCH₂CH₂-
 COOH

PET Berberine
 PET FT -
 IR XPS PET COOH
 COOH 가 PET
 COOH 가 PET

PET COOH 가
 PET

berberine
 berberine
 FT - IR KBr
 Figure 6 Figure 6
 3300 cm⁻¹ 1300 cm⁻¹
 , 2800 cm⁻¹ CH ,
 1620 cm⁻¹ C=C 1100
 cm⁻¹ C-O
 Figure 1 berberine

berberine 3%(o.w.f.)
 , 1:80, 100 , 100
 1.5 cm
 PET ber -

berine pH
 Figure 7 Figure 7
 COOH 가 berberine
 가

sodium bicarbonate
 pH가

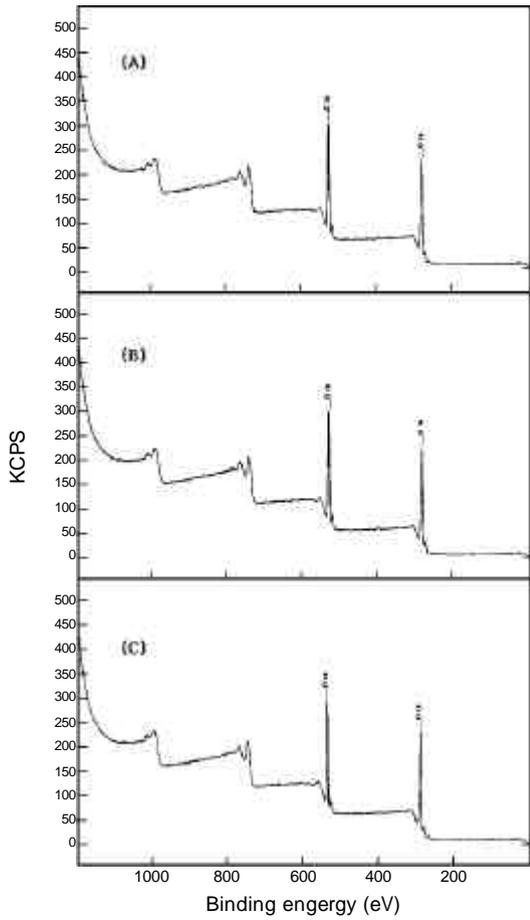


Figure 9. Change of XPS spectra of PET UV-irradiated for 30 min : (A) 3 days, (B) 6 months, and (C) 12 months.

Table 2. Change of Relative Intensities of C_{1s} and O_{1s} in wide Scanning XPS of PET Fibers UV-Irradiated for 30 min

chemical composition	time	3 days	6 months	20 months
O_{1s}		31.49	31.11	30.15
C_{1s}		67.16	67.48	68.20

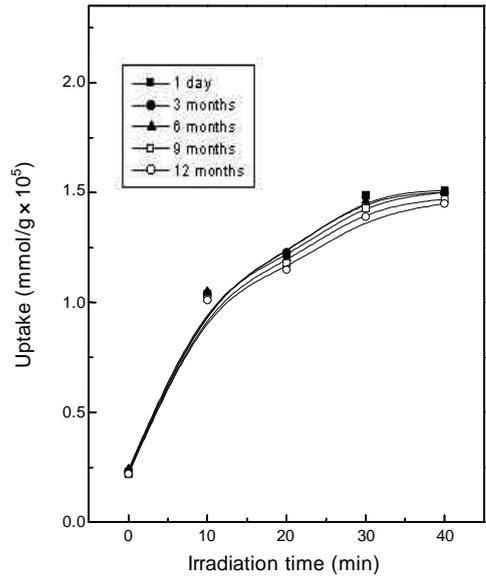


Figure 10. Relationship between uptake values of berberine and lapse of times.

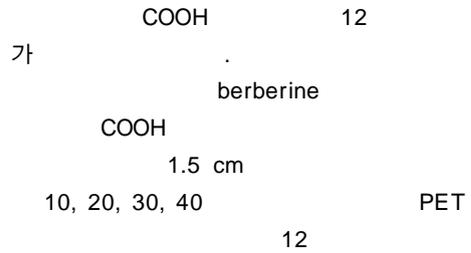
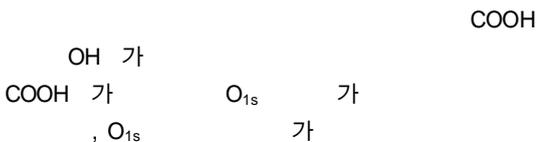
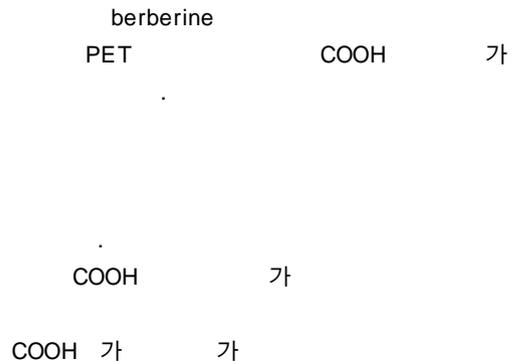


Figure 10

Figure 10



berine 4
 PET 1.5 cm
 10, 20, 30, 40
 berberine Bioassay Table 3
 Table 3 가 99% 4
 COOH 4
 PET 가 berberine
 32,33 4

Table 3. Reduction Rates of Bacteria of UV-Irradiated PET Fibers Adsorbed with Berberine

treatment	reduction rate(%)
unradiated	21.0
10 min	92.4
20 min	96.6
30 min	99.2
40 min	99.9

berine
 PET COOH 가 COOH 가
 berberine PET
 Figure 11 PET 23%
 berberine PET 가
 가 30 120
 75% PET 가
 COOH 가 PET
 가 FT - IR, XPS
 가 COOH

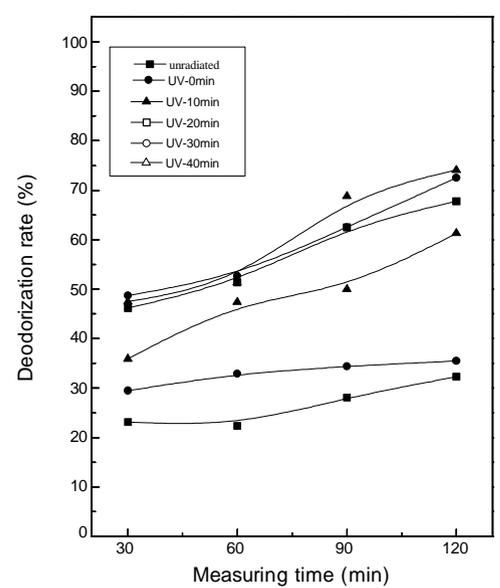


Figure 11. Deodorization rates of UV - irradiated PET adsorbed with berberine.

가 berberine 75%
4

PET 가 berberine
PET
가
PET 가 가
PET
1. FT - IR (COO) 1720 cm⁻¹
가
2. XPS O_{1s} 가 가 30
O_{1s} 가 7% 가
3. XPS C_{1s}
PET
가 C - H COO
PET C - H
COOH 가
4.
COOH 가 가 PET
5. XPS
COOH
12 가
6. Berberine PET
30 99%

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