Photocatalytic Activity of Coated Pet Fabrics with Synthesised Nano TiO_2

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ABSTRACT

Different concentration of TiO_2 sols (10-40% g/l) synthesized by titanium tetra isopropoxide (TTIP). PET fabric dipped in prepared sols and sol-gel process accomplished at low temperature. Particle size of synthesised Nano TiO_2 determined by particle size analyzing and morphological characteristics of treated samples analysed by scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS) and crystalline structure of synthesis particles by X-ray diffraction method (XRD). Methylene blue (MB) used for photocatalytic evaluation. Treated samples exposed with UV light in a methylene blue bath and the amount of discoloration determined by UV-visible spectrophotometery method. Results showed that increasing the amounts of TiO_2 on the surface of PET fabric improves the photocatalyic activity.

***Keywords* :** TiO2, Sol-gel, Polyester, Photocatalysis

1 INTRODUCTION

There are plenty of inorganic UV-absorbing nanometer materials which can be used as UV-absorber, such as nano-TiO_2, nano-ZnO, nano-SiO_2, nano Al_2O_3, nano-FeO, etc [1]. In order to desirable properties, titanium dioxide has essentially proved itself to be the best material for environmental purifications. TiO_2 is a cheap, readily available, highly stable chemically material and its photogenerated holes are highly oxidizing. In addition, TiO_2 is capable of oxidising a wide range of organic compounds and invert them into harmless compounds such as CO_2 and H_2O [2]. By uniformly distributing nano-TiO_2 on the surface of Poly(ethyleneterephthalate) (PET), many applications arise due to improving of its physical properties [3]. The Decomposition of the macromolecule chains could be effectively inhibited and free radicals could be reduced.

2 EXPERIMENTAL

2.1 Nano-TiO_2 prepared by sol-gel method

The solution of TTIP (titanium tetra iso propoxide; Merch chemical) and 2-propanol was added gradually into mixture of deionized water and 2-propanol under vigorous stirring. The white precipitate was filtered and washed with distilled water to remove starting materials and dried at room temperature for 24 h. Then 1, 2 and 4 g of the obtained white powder refluxed for 24h at 70˚C to gain sols of 1%, 2% and 4% wt/wt and the pH value of the system was adjusted at 1.5.

2.2 Fabric treatment

The polyester fabrics immersed into nano-TiO_2 sols with different ratios by dipping method at 60C for 40 min, then dried at 115 ˚C for 1 h.

2.3 Samples characterizations

The TiO_2 sol was evaporated and dried at 120 ˚C for 24 h and calcined at 400˚ C for 3 h. The crystallization phase of the prepared nano-TiO_2 powder was characterized by X-ray diffraction analyzer (Philips, PW 1800). The particle size distribution was also measured in dilute aqueous sols by particle size analyzer (Zeta Sizer HS 3000).

The surface morphology of the film was observed using scanning electron microscopy (SEM, Philips, Netherlands). The elemental analysis of the film was performed using energy dispersive spectroscopy (EDS).

2.4 Photocatalytic activity evaluation

Raw and treated samples placed separately in methylene blue aqueous solutions (10 ppm), and placed in a labratoray UV cabinet (15W UV-C lamp, Philips Co) for up to 3 hrs with 0.5 hr steps. Absorbance of the solution samples by UV-Vis spectrophotometer (Varian), at λmax = 594 nm.

The decolourization speed of solutions (decreasing the concentration of methylene blue) used for the investigation of photocatalytic activities of different samples.

3 RESULTS AND CONCLUSIONS

SEM micrographs clearly show that treated fibers are covered by a homogenously dispersed TiO_2 particles (Figure 1b). EDS results show that TiO_2-coated fabric contain remarkable amount of 16.36% Ti in Fig 1b.

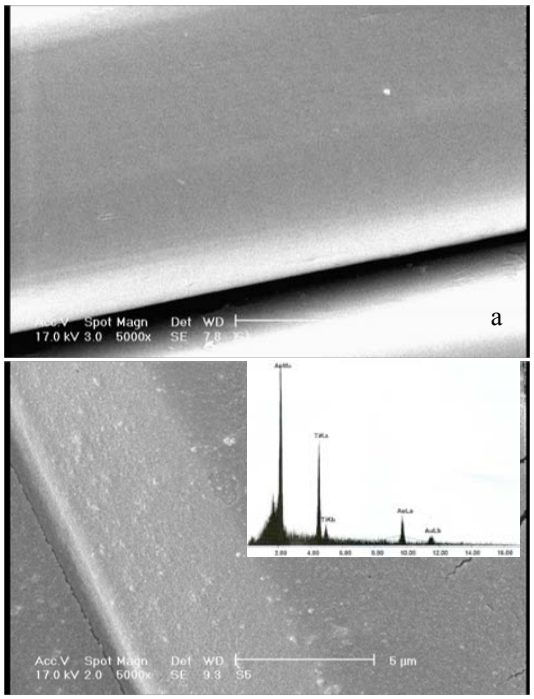

Figure 1(a & b). SEM images of the surface distribution of unfinished and finished polyester fabrics

Fig 2 shows the XRD graph.A maximum diffraction peak when 2theta reaches to 25.3˚, just corresponds the diffraction peak of the crystal plane of anatase type TiO_2 (101). Different diffraction peaks appeared when the diffraction angle reaches 37.9˚, 48˚and 55˚ matching along separately with the crystal plane of anatase type. If the maximum peak of nano-TiO_2 is narrow-and-acuate-oriented, the half-peak width would be narrow-oriented accordingly and the corresponding crystallinity would be better with comparatively intacr crystal form.

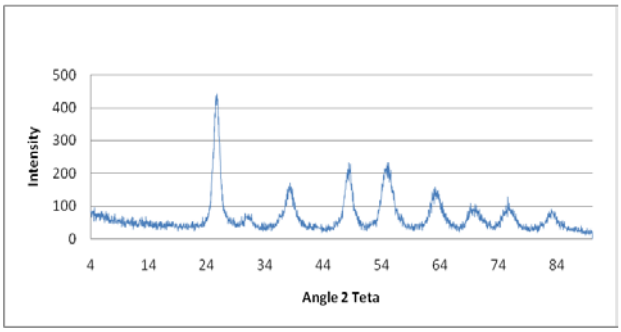

Figure 2.X-raydiffraction patterns of Nano-TiO_2 crystals

The average particle size of the nanometer particles is 26.9nm ranging uniformly between 6.7nm to 67.6nm which illustrates that high-purity nano-TiO_2 sol could be readily prepared undertaking sol-gel method (Fig 3).

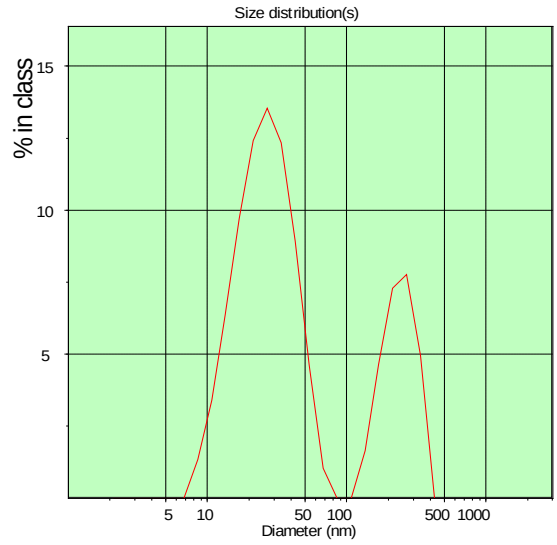

Figure 3. The Nano-TiO_2 particle size distribution

3.1 Photocatalytic degradation

Treated PET fabrics with sol containing 4% wt/wt showed higher percentage of MB decolorization (Table 1), in compare with other samples after finishing illumination process. PET+TiO_2 4% wt/wt fabric provided near complete removal of MB solution. The PET+TiO_2 4% wt/wt fabric remained white after 3h degradation of MB. On the contrary the other sample fabrics were spotted pale blue.

Investigation of photocatalytic degradation process of MB under UV-C irradiation indicates that two main species have the major contributions: (1) electronesand holes (h^+_{VB},e^-_{CB}). (2) hydroxyl radicals. The importance of these depends on the substrate structure and operational parameters such as pH. It is established that pH of 6.8 has the highest degradation of MB compare to pH of 4.5 and 8.5. The photocatalytic activity of TiO_2-coated fibers is attributed to the dispersed anatase with satisfactory crystallized on the fabric surface. It is evident that TiO_2-covered fibers promote the photodegradation process and high surface area associated with the small particle size and anatase crystalline phase ensures a favorable condition for a relatively fast degradation.

Table 1. Percentage of MB degradation after different time of UVC exposuring time (hr)

	Percentage of MB degradation after different time of UVC exposuring time (hr)					
Sample	0.5	1	1.5	2	2.5	3
1% wt/wt	28	38	48	59	64	73
2% wt/wt	31	43	53	61	67	75
4% wt/wt	50	60	68	77	81	87

4 CONCLUSIONS

Coating the surface of PET fabric with TiO_2 nano particles, implies photocatalytic activity to treated fabric. Increasing the amount of TiO_2 nano particles on the fabric surface improves the produced property. Measuring methylene blue solution discoloration can be accounted as photocatalytic activity of the surface.

ACKNOWLEDGMENT

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