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STRUCTURAL AND MORPHOLOGICAL PROPERTIES OF Y-TiO_2

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ABSTRACT

Water pollution by organic matters are in increase. Photocatalytic degradation of various pollutants presented in environment has promising future. Different materials have been applied in previous scientific works, while TiO_2 based materials posse's great physico-chemical characteristics. Therefore, researchers are constantly developing various heterostructures with advanced properties with aim to readily degrade present pollution. In this paper, our goals was to investigate structural and morphological properties of novely synthesized Y-TiO_2 photocatalyst. With those purposes, several tests were done, like Scanning electron microscopy (SEM), Energy-dispersive X-ray spectroscopy (EDS), structural stability (SS) etc. Results show that obtained material has prominent photocatalytic activity in five consecutive cycle.

1. INTRODUCTION

Different organic and inorganic agents in waters can potentially cause detrimental effects on living organisms. Fate of their chemical transformations depends on environmental conditions, *i.e.* redox potential, temperature, scavengers, etc. Therefore, qualitative and quantitative determinations of their presence is necessary.

Different treatment processes could be applied in order to remove undesirable elements from water. From capital and operating costs to environmental effect, operability, efficiency, pre-treatment requirements, and the production of hazardous byproducts and sludge, each treatment process has its own "pros and cons" [1]. Photocatalysis, as one of the modern oxidative techniques, possesses potential to effectively decompose or transform existent pollutants, both organic and inorganic. Complex redox processes are exemplified by photocatalysis, in which various forms of irradiation interact with the catalyst surface to break down pollutants in the system and produce h^+/OH^- species [2].

Various materials were developed in order to boost the degradation rate. One of the most applied oxides is TiO_2, in different mineralogical form (rutile, anatase, and brookite). Due to easy procesability, durability under process conditions, the possibility of multicycle usage made TiO_2 one of the most promising material as photocatalysts. In order to decrease necessary reaction time, many scientists trying to develop efficient photocatalysts applying different processes and heterostructures. Rare earth elements have a special place in this area [3].

The aim of this work is to present fabricated photocatalyst Y-TiO_2. During a detail investigation, structural properties together with photocatalytic properties were determined.

2. MATERIALS AND METHODS

Photocatalyst was synthesized following the procedure from paper Jovanovic et al [4]. Prepared photocatalyst undergo structural characterization employing Scanning electron microscopy (SEM) JEOL JSM-7001F (Japan). Presence of various elements and their share is determined by energy-dispersive X-ray spectroscopy (EDS), (Oxford Xplore 15, UK). In detail, the operational parameters of used instruments is described in paper Bugarčić et al [5]. Structural stability of photocatalyst was determined by proposed operational conditions in consecutive working cycles [4].

3. RESULTS

3.1. SEM and EDS characterization

The photocatalyst's SEM micrograph is shown in Figure 1.

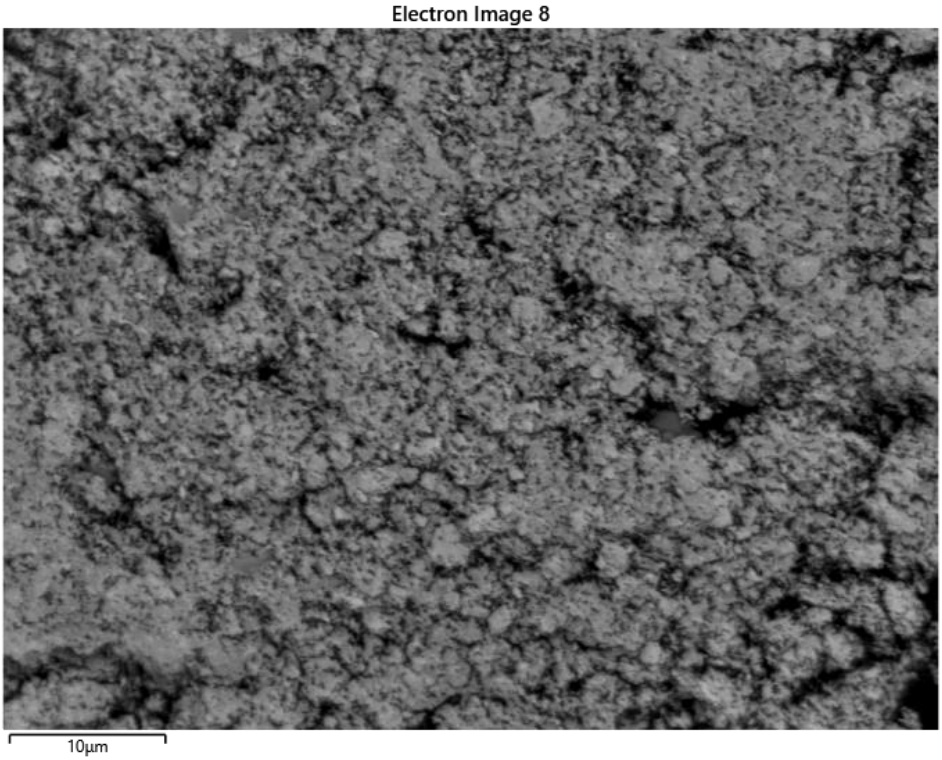

Figure 1. SEM of Y-TiO_2 particles.

As shown at Figure 1, the majority of photocatalyst particles are spherical nanoparticles (usually cubic with edges ~ 50 nm). Particles that are deposited on TiO_2 are in range size from 50 nm for single particles to 250 nm for large flakes.

In Table 1 are presented elements found in prepared material during thoughtfully analysis by the EDS method.

Table 1. SEM-EDS calculations of element presence from SEM (Figure 1).

Element	Line Type	Weight %	Weight % Sigma	Atomic %	Oxide	Oxide %	Oxide % Sigma
O	K series	36.16	0.05	63.56			
Al	K series	0.48	0.02	0.50	Al_2O_3	0.90	0.03
Si	K series	0.11	0.02	0.11	SiO_2	0.24	0.04
Cl	K series	4.88	0.02	3.87		0.00	0.02
Ti	K series	49.88	0.06	29.28	TiO_2	83.20	0.10
Y	L series	8.49	0.06	2.68	Y_2O_3	10.78	0.08
Total		100.00		100.00		95.12	

SEM-EDS analyses of the surface of the specimens under examination revealed six elements in the manufactured photocatalysts. Different amounts of oxygen (O), titanium (Ti), aluminum (Fe), silicium (Si), chlorine (Cl) and yttrium (Y) are present obtained material. Presence of Si, Al and Cl could be explained by not-analytically pure chemicals used for photocatalyst synthesis. The successful manufacturing of Y-TiO_2 composite is supported by the consistent distribution of the aforementioned elements shown in Table 1.

3.2. Photocatalytic properties

Figure 2 shows the results of five successive cycles of testing the uniformity and durability of the produced catalyst under ideal operating circumstances. The produced material and the initial TiO_2 photocatalyst were compared.

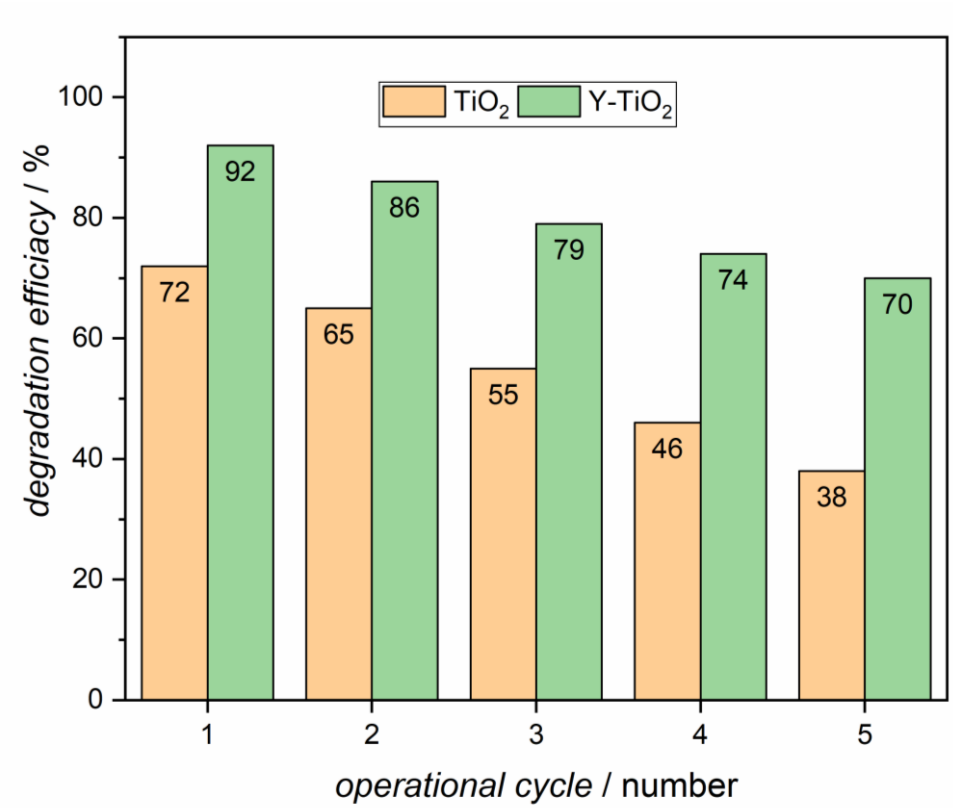

Figure 2. Catalyst multicycle efficiency (cycle time matched the required full degradation for selected photocatalyst).

Strong linkages between the TiO_2 surface and Y deposits are responsible for the increased stability, as seen by the applied catalysts' degradation efficiency decreasing significantly from 92% to 79% after the third reaction cycle. The washing solution showed no signs of yttrium at rinsing of catalyst after each cycle. The 80% of the catalyst activity remained after the fifth cycle.

4. CONCLUSION

As a wastewater treatment method, photocatalysis is demonstrating promising outcomes. When it comes to photocatalytic degradation, applied photocatalyst have demonstrated remarkable efficiency. Base TiO_2 has the best stability, whereas photocatalyst Y-TiO_2 exhibits the best results in terms of degrading efficiency. As anticipated given that the bonds in the materials deteriorate with time, the stability of the produced material decreased after each operational cycle.

5. ACKNOWLEDGEMENT

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