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A comparative study of the photocatalytic degradation of RB-19 dye on TiO_2 nanoparticles and TiO_2/C nanocomposites

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Abstract – TiO_2-coated carbon (TiO_2/C) composites and pure TiO_2 nanoparticles were prepared by a sol–gel method using titanium tetra-isopropoxide (TTIP) and furfuryl alcohol (FA) as precursors. In both cases the samples was obtained after calcinations, under argon flow, between 400-900 °C. All samples were characterized by X-ray diffraction (XRD), FT-IR and Raman spectroscopy. The photoactivity was evaluated by UV–visible spectroscopy using the dye Reactive Blue 19 (C.I. 61200, RB19) as a standard substrate. Results show that the TiO_2 and the TiO_2/C composites have different photoactivity when submitted to different calcination temperatures, due the anatase/rutile proportion present in each sample.

Organic dyes are one of the largest groups of pollutants released into wastewaters from textile and other industrial processes. Because of potential toxicity of the dyes and their visibility in surface waters, removal and degradation of organic dyes have been a matter of considerable interest. A wide range of methods have been developed, amongst which the heterogeneous photocatalysis involving titanium dioxide (TiO_2) appears to be the most promising technology [1].

The properties of materials based on a modified titania matrix have been extensively studied, the main interest being in their unique electrochemical, optical, catalytic, semi-conducting and redox properties. Additionally, due to their low toxicity, appropriate energy band configurations for charge transfer at the interface, and absorption in the near UV range, titania-based catalysts are widely used [2]. Photocatalysis based on anatase-type TiO_2 catalyst has been considered a promising process for environment conservation and remediation. Recently, some studies in the literature has been developing successfully hybrid carbon-coated TiO_2 particles for photocatalytic activity and adsorption [3], but few studies report the rutile phase/C with good results.

In this work we present a novel route to prepare TiO_2/C composite, based on the calcinations of TiO_2/poly-furfuryl alcohol materials, and the utilization of these TiO_2/C composites as photocatalyst. TiO_2 nanoparticles prepared in similar way were also employed to comparison. The structural phases of TiO_2 in each sample were evaluated by both Raman and XRD. The occurrence of amorphous sp^2-based carbonaceous material in each sample was also verified through these techniques. Results indicate that the anatase to rutile phase transition occurs in higher temperatures to the carbon-containing samples. The photocatalytic responses for the RB19 dye are showed in Figures 1 and 2, for the samples TiO_2 and TiO_2/C, respectively, at different temperatures. It is noticeable a very high photocatalytic response for the sample TiO_2/C heat-treated at 900 °C, in spite of the rutile structure presented by the TiO_2 in this temperature. This interesting effect has been attributed to an effective C-TiO_2 interaction in this sample.

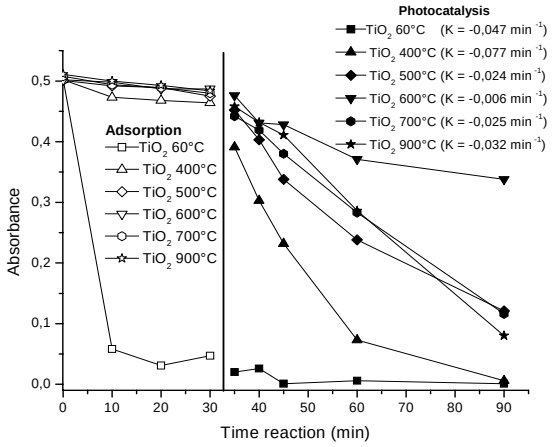

Figure 1: Effect of pyrolysis temperature on the adsorption and degradation of the dye for the samples of pure TiO_2 nanoparticles.

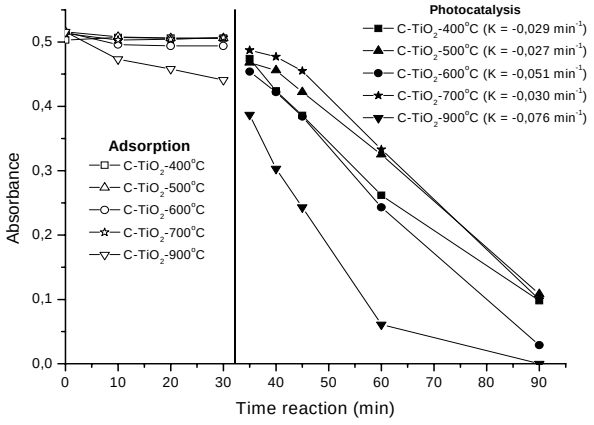

Figure 2: Effect of pyrolysis temperature on the adsorption and degradation of the dye for the samples of TiO_2/C composites.

References

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[3] M. Toyoda, et. al. Appl. Catal. B: Environ. 88 (2009) 160–164.