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# $TiO_2$ Deactivation Process during Photocatalytic Ethanol Degradation in the Gas Phase

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**Abstract :** The efficiency of the semiconductor $TiO_2$ needs to be improved to be an effective tool for pollutant removal. To improve the efficiency of this semiconductor, it is necessary to deepen the knowledge of the processes that take place on its surface. In this sense, the deactivation of the catalyst is one of the aspects considered relevant. In order to study this point, the processes of deactivation of $TiO_2$ during the gas phase degradation of ethanol have been studied. For this, catalysts with only the anatase phase (SA and PC100) and catalysts with anatase and rutile phases (P25 and P90) have been selected. In order to force the deactivation processes, different cycles have been performed, adding ethanol gas but avoiding the degradation of acetates to determine their effect on the process. The surface concentration of fluorine on the catalysts was semi-quantitatively determined by EDAX analysis. The photocatalytic experiments were done with four commercial catalysts (P25, SA, P90, and PC100) and the two fluoride catalysts indicated above. The interaction and photocatalytic degradation of ethanol were followed by Fourier transform infrared spectroscopy (FTIR). EDAX analysis has revealed the presence of sodium on the surface of fluorinated catalysts. In FTIR studies, it has been observed that the acetates adsorbed on the anatase phase in P25 and P90 give rise to electron transfer to surface traps that modify the electronic states of the semiconductor. These deactivation studies have also been carried out with fluorinated P25 and SA catalysts (F-P25 and F-SA) which have observed similar electron transfers but in the opposite direction during illumination. In these materials, it has been observed that the electrons present in the surface traps, as a consequence of the interaction Ti-F, react with the holes, causing a change in the electronic states of the semiconductor. In this way, deactivated states of these materials have been detected by different electron transfer routes. It has been identified that acetates produced from the degradation of ethanol in P25 and P90 are probably hydrated on the surface of the rutile phase. In the catalysts with only the anatase phase (SA and PC100), the deactivation is immediate if the acetates are not removed before adsorbing ethanol again. In F-P25 and F-SA has been observed that the acetates formed react with the sodium ions present on the surface and not with the Ti atoms because they are interacting with the fluorine.

**Keywords :** photocatalytic degradation, ethanol, $TiO_2$, deactivation process, F-P25
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