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# The effects of Fe, Co and Ni dopants on $TiO_2$ structure of sol–gel nanopowders used as photocatalysts for environmental protection: A comparative study

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**Abstract**

This paper highlights the effects of iron, cobalt and nickel dopants on the structure and photocatalytic properties of the sol–gel $TiO_2$ nanopowders and performs a comparative study of their behavior. Undoped $TiO_2$ and 0.5, 1 and 2 wt% Fe, Co and/or Ni-doped $TiO_2$ nanopowders have been prepared. The compositions with 0.5 wt% dopant were selected for this study considering that the best results have been obtained using iron dopant with this concentration. A detailed XRD analysis, based on an own calculus program, has established the lattice parameters, the average size of the crystallites (*D*), the unit cell volume (UCV) and the average lattice strains (*S*), which can give some information about the structural disorder. The structural changes due to the thermal treatment and the type of the dopant were established. The dopants addition is responsible for supplementary defects in the crystalline lattice. Besides the mobile single point defects due to the thermal treatment, the dopants induce the paramagnetic ones. The increase of temperature does not significantly influence the unit cell volume (UCV). This fact could be considered as a proof of the acceptance of the dopant by the anatase lattice, where $Me_xTi_{1-x}O_{2-\delta}$ type solid solutions are formed. The variation of the (*D*) and (*S*) values with temperature, calculated for both undoped and doped $TiO_2$ samples indicates the fact that the highest disorder state was found at 400 °C. The photocatalytic activity of the prepared nanopowders has been tested in the degradation of nitrobenzene from water. The sample with 0.5 wt% Fe dopant concentration thermally treated at 400 °C presented the best photocatalytic activity.


*Keywords:* A. Sol–gel processes; B. X-ray methods; D. $TiO_2$; Photocatalysts

## 1. Introduction

The semiconductor photocatalysts have been one of the fastest growing research areas in the environmental protection field in the past decades. Recently, the new approach for wastewater treatment is based on $TiO_2$ assisted photocatalysis through so-called Advanced Oxidation Processes (AOPs), as a possible alternative to conventional water treatment technologies [1]. It is considered an efficient degradation method of xenobiotic compounds, such as nitroaromatic ones, which can be applied for the conversion of toxic pollutants into biodegradable intermediates or for their mineralization in a wastewater treatment flow. Photocatalysis has attracted much attention as ''an environmentally benign catalyst'' because photocatalysts possess a potential to oxidize organic compounds into nontoxic $CO_2$ and $H_2O$, decompose NOx, and reduce $CO_2$ under UV light irradiation. Hence, the photocatalytic system is often represented as ''an artificial photosynthesis'' [2]. It is well known that among the various

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