PRISTINE AND Pt-MODIFIED TiO_2 DRIVEN ORGANIC COMPOUNDS PHOTODEGRADATION

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INTRODUCTION & AIM

Photocatalysts powders with different compositions, sizes and dimensional distributions were prepared by sol-gel method.

The purpose of this work was to prepare, by the sol-gel method, TiO_2 and Pt-modified TiO_2 with photocatalytic activity for ethanol degradation in gaseous phase under simulated solar light irradiation.

METHOD

The powders were obtained by sol-gel method and noted: TiO_2 and TiO_2-Pt (doped by post-synthesis impregnation). The methods used for characterization were infrared spectroscopy (FT-IR), transmission electron microscopy (TEM), X-ray diffraction (XRD), X-ray fluorescence(XRF), UV-Vis and BET-specific surface area determination. The products of oxidative degradation process were analyzed by gas-phase chromatography (GC-TCD and GC-FID).

SYNTHESIS

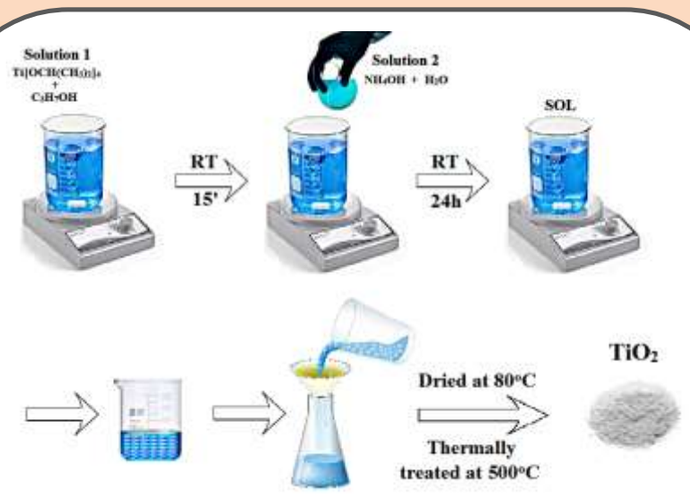
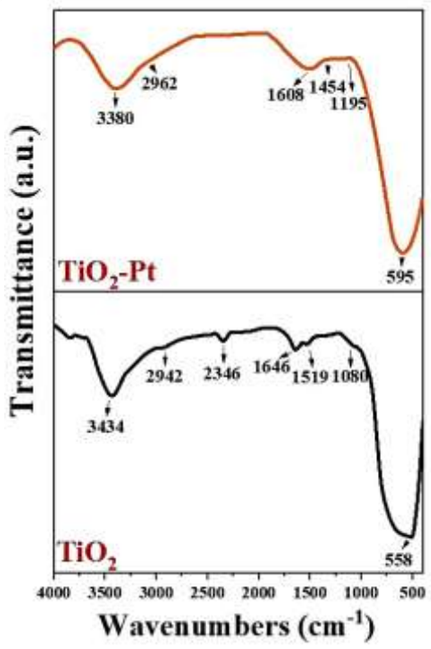


Fig. 1. TiO_2 preparation by the sol-gel method.

- Reagents: Titanium isopropoxide for TiO_2 source and $PtCl_4$ for dopant (1 mol%).
- The samples obtained were white (TiO_2) or light grey (TiO_2-Pt) powders.

RESULTS & DISCUSSION

FT-IR



Tab. 1. Assignment of vibration bands of thermally treated powders.

Wavenumbers (cm^{-1})		Assignments and vibration bands
TiO_2	TiO_2-Pt	
558	595	Ti-O stretching vibration of TiO_6
1080	-	C-O
-	1195	
-	1454	$\nu_s(CO_3)^{2-}$
1519	-	$\nu_{as}(CO_3)^{2-}$
1646	1608	δH_2O (adsorbed water)
2346	-	CO_2 (absorption)
2942	2962	C-H, $\nu_{as}(CH_3)$
3434	3380	νOH (structural OH group)

Fig. 2. IR spectra of thermally treated powders.

- The small displacement to higher wavelength values in case of TiO_2-Pt is assigned to the presence of noble metal in the composition of the investigated sample.

TEM

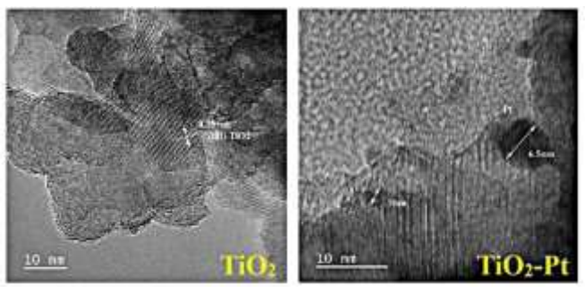


Fig. 3. TEM micrographs of the samples.

- The TiO_2 sample is formed by aggregates crystallites with dimensions of 20-60 nm.
- TiO_2-Pt present Pt nanoparticles are spherical and have dimensions from 2.5 nm to 6 or 7 nm.

XRD

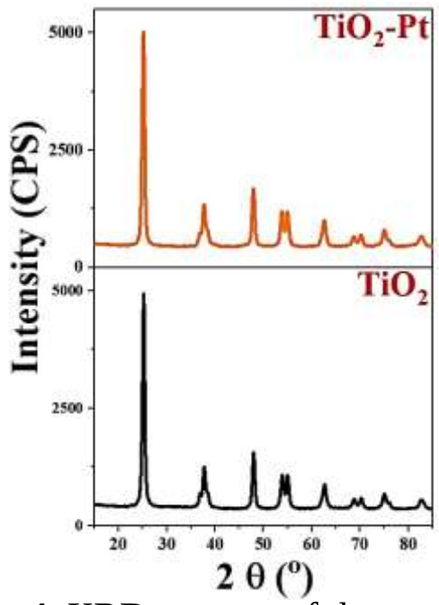


Fig. 4. XRD patterns of the samples.

- Both samples exhibit a single-phase anatase TiO_2 structure.
- Addition of Pt does not significantly alter the anatase phase composition.

XRF

Tab. 2. Elemental composition of the powders.

Sample	Composition	Values (Mass %)	Line
TiO_2	Ti	59.25	Ti-KA
	O	39.57	O-KA
	Traces	1.18	
TiO_2-Pt	Ti	59.32	Ti-KA
	O	38.25	O-KA
	Pt	1.05	Pt-LA
	Traces	1.38	

- The analysis confirmed the presence of platinum (Pt) in the Pt-doped sample in quantities closely matching the initially calculated composition, indicating successful incorporation of Pt into the material.

BET

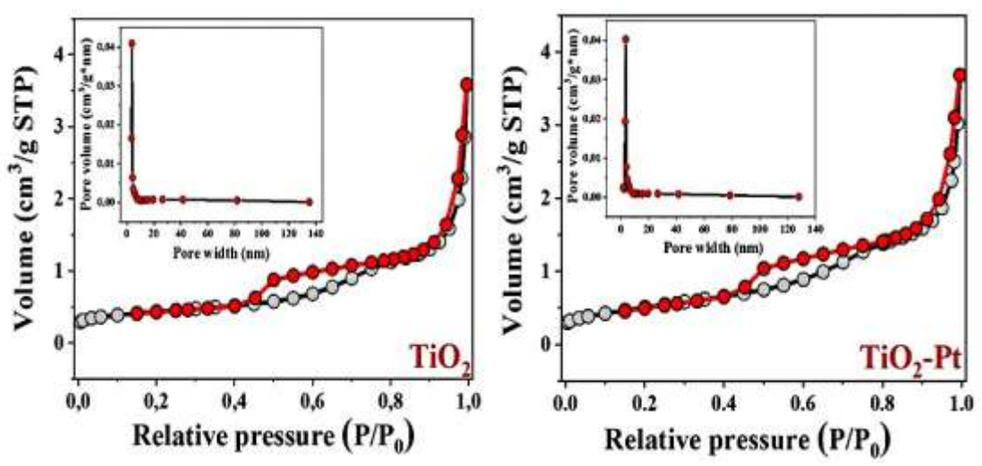


Fig. 5. N_2 adsorption-desorption isotherms and pore size distributions (insert in the figures) of powders.

- Both samples exhibit type IV(a) isotherms which is characteristic of mesoporous materials.

UV-Vis

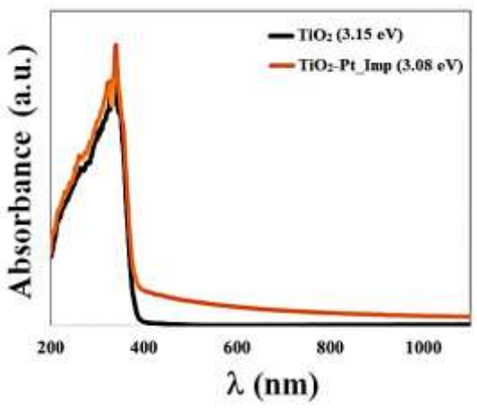
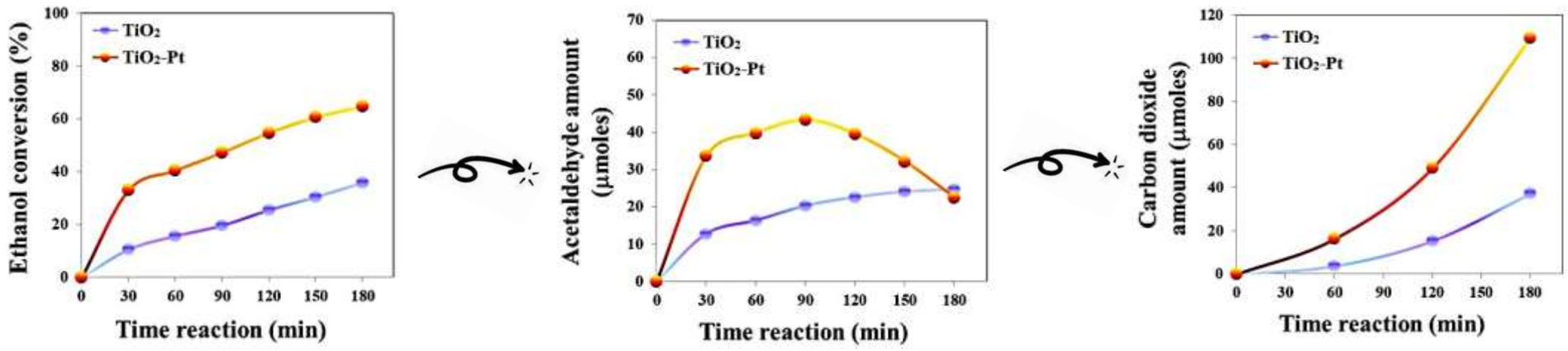


Fig. 6. UV-Vis absorption spectra.

- The samples present a strong absorption in the UV region, with a sharp peak at ~340 nm, characteristic toTiO_2.

Oxidative photodegradation of ethanol in gaseous phase under solar simulated light



- Oxidative degradation of ethanol leads to acetaldehyde (CH_3CHO) and then, through successive reactions, to the intermediate formation of formic acid (HCOOH - in trace amounts) and finally to CO_2.

CONCLUSIONS

- TiO_2 powder were obtained using the sol-gel method, and doping with Pt by post-synthesis impregnation.
- The structural and morphological characterizations of the obtained photoactive materials were correlated with their photocatalytic activity.
- After 3 hours of solar simulated light irradiation, TiO_2-Pt powder achieved the highest conversion of ethanol photodegradation (64.82%).
- Addition of Pt improves the catalytic activity by: co-catalytic effect, decrease of bandgap, better light absorption and separation of charges.