



La₂Ti₂O₇ doped with Pt, obtained by sol-gel method, with photocatalytic activity in the oxidative degradation of ethanol



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INTRODUCTION & AIM

The present work investigates the sol-gel synthesis of La₂Ti₂O₇ perovskite and its photocatalytic performance in ethanol oxidative degradation under simulated solar light, emphasizing the effect of Pt impregnation, reaction products evolution in time, and the correlation between structure, morphology, and activity.

METHOD

The powders were obtained by sol-gel method and noted: LTA and LTA-Pt. The methods used for characterization were infrared spectroscopy (FT-IR), scanning electron microscopy (SEM), 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

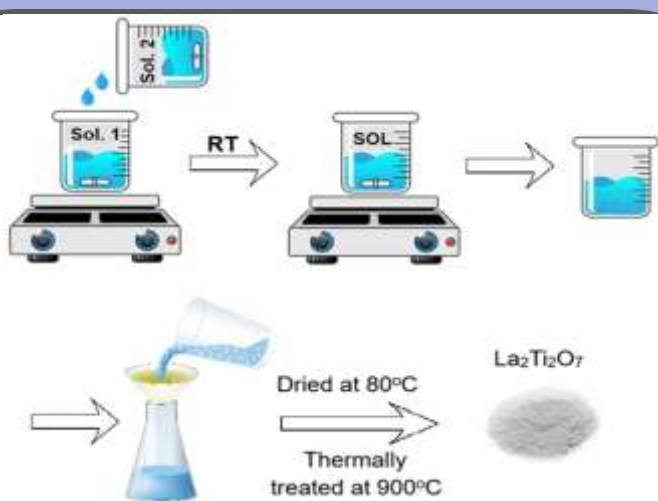


Fig. 1. La₂Ti₂O₇ preparation by the sol-gel method.

- Reagents: lanthanum (III) nitrate hexahydrated as the La precursor, titanium (IV) isopropoxide as the precursor of Ti and PtCl₄ for dopant (1 mol%).
- The samples obtained were white (LTA) or light grey (LTA-Pt) powders.

XRD

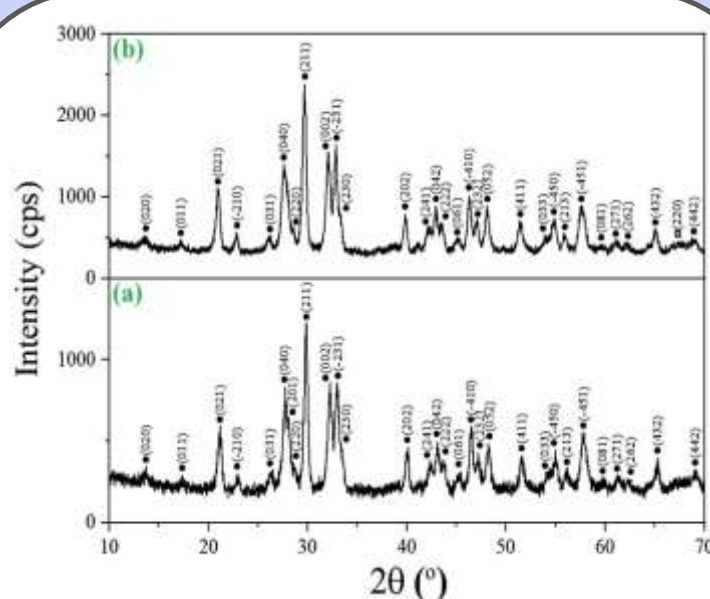


Fig. 4. XRD patterns of the samples: (a) LTA and (b) LTA-Pt.

- XRD analysis confirmed the formation of single-phase La₂Ti₂O₇ with monoclinic structure, both for pristine and Pt-impregnated samples.

UV-Vis

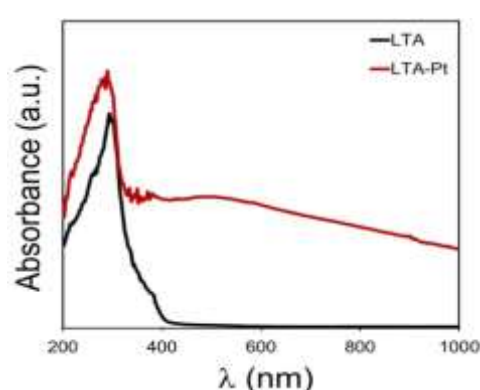


Fig. 6. UV-Vis absorption spectra.

- The obtained experimental values were 3.78 eV for LTA and 3.83 eV for LTA-Pt, being close to the literature data reported for La₂Ti₂O₇ samples.

RESULTS & DISCUSSION

FT-IR

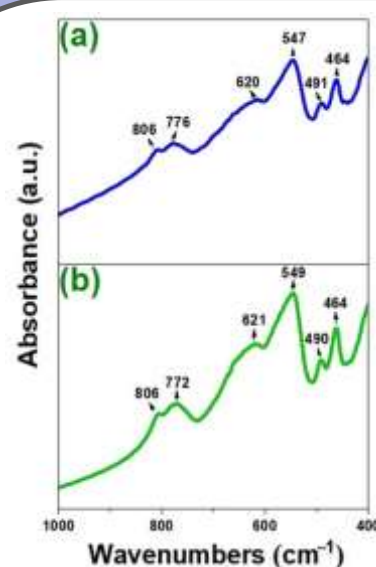


Fig. 2. FT-IR spectra of the (a) LTA and (b) LTA-Pt.

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

Wavenumbers (cm ⁻¹)		Assignments and Vibration Mode
LTA	LTA-Pt	
806	806	Ti-O-Ti bridges in TiO ₆ octahedra from titanate
776	772	Ti-O stretching in TiO ₆ octahedra from titanate
620	621	La-O stretching and Ti-O vibrations
547	549	La-O stretching and Ti-O vibrations
491	490	La-O stretching vibrations and Ti-O-Ti bridges in TiO ₆ octahedra
464	464	La-O stretching vibrations and Ti-O bending modes

- The vibration bands between 800 and 400 cm⁻¹ are assigned to metal-oxygen (M-O) stretching vibrations, suggesting the formation of La-O and Ti-O networks.

- No changes are observed due to the incorporation of the Pt into the perovskite structure.

SEM

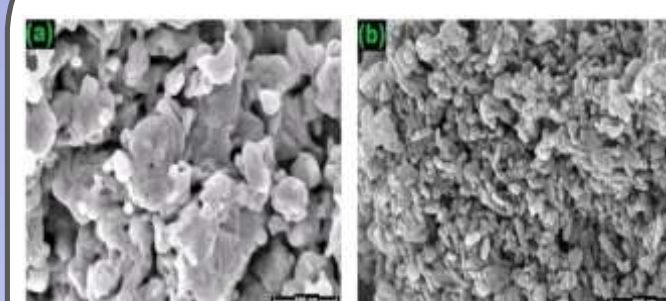


Fig. 3. SEM micrographs of the samples.

- The LTA sample shows irregular particles with a size ranging between 50 and 100 nm.
- In the case of the LTA-Pt sample, a better individualization of the particles can be observed, as they are less aggregated, with uniformly distributed Pt.

XRF

Tab. 2. Elemental composition of the powders.

Sample	Composition	Values (Mass %)	Line
LTA-Pt	Ti	26.46	Ti-Kα
	La	72.50	La-Lα
	Pt	1.03	Pt-Lα

- The results, presented in Table 2, indicate that platinum (Pt) was detected in quantities closely matching the initially calculated composition.

BET

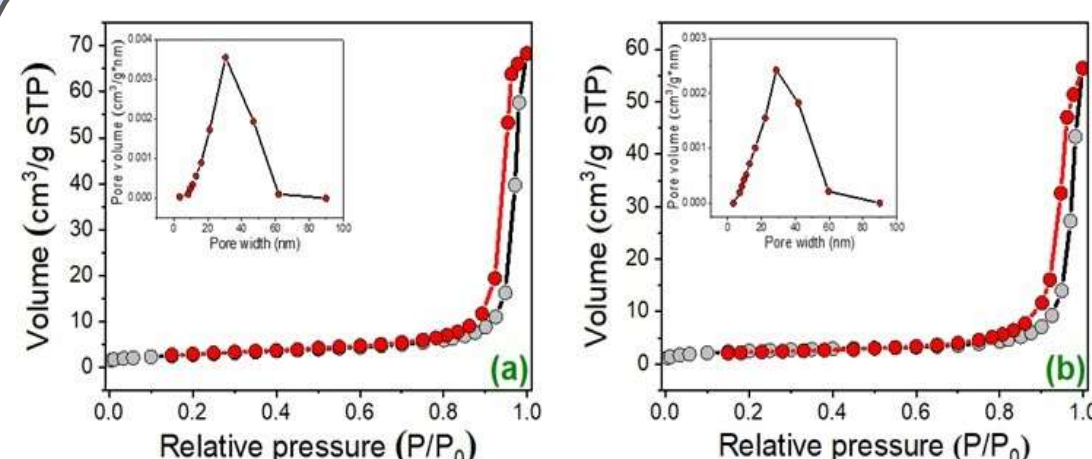
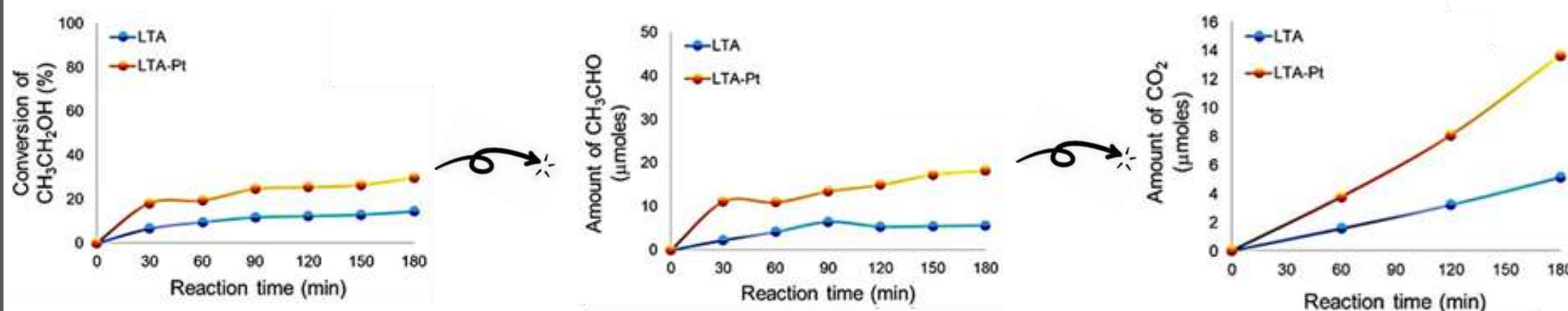


Fig. 5. N₂ adsorption-desorption isotherms and pore size distributions of (a) LTA and (b) LTA-Pt samples.

- Both samples show mesoporous structures with contributions from macropores, as indicated by the type IV isotherms with H3 hysteresis loops and the broad PSD profiles.

Oxidative photodegradation of ethanol in gaseous phase under solar simulated light



- Oxidative degradation of ethanol leads to acetaldehyde (CH₃CHO) and then, through successive reactions, to the intermediate formation of formic acid (HCOOH - in trace amounts) and finally to CO₂.

CONCLUSIONS

- La₂Ti₂O₇ perovskite was successfully synthesized by the sol-gel method, and its photocatalytic properties were improved by Pt modification.
- The materials showed mesoporous nanoparticle aggregates and single-phase crystalline structure.
- Platinum enhanced charge separation and oxygen activation, leading to higher ethanol conversion and CO₂ selectivity.
- These results highlight the potential of Pt-La₂Ti₂O₇ powders for air depollution applications.