IOCPC 2026 Conference

The 1st International Online Conference on Photochemistry

06–07 April 2026 | Online

MDPI

Cobalt and iron-exchanged $LiLaTa_2O_7$ layered perovskites and their applicability in sustainable photocatalytic processes

Monica Pavel, Irina Atkinson, Crina Anastasescu, Florica Papa, Ioan Balint*

Institute of Physical Chemistry – Ilie Murgulescu, 202 Spl. Independentei, 060021, Bucharest, Romania

e-mails: (M.P.) mpavel@icf.ro; (I.B.) ibalint@icf.ro

INTRODUCTION & AIM

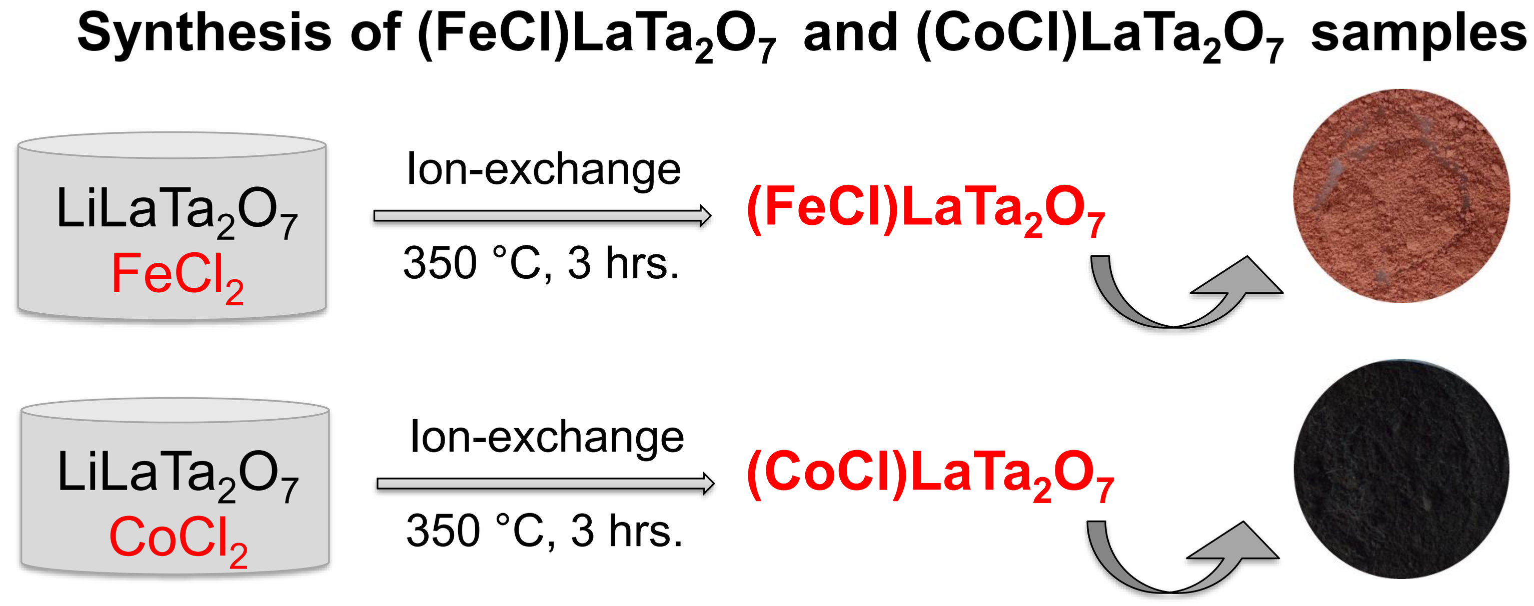
Solar energy catalysis is a key sustainable technology that leverages photocatalysts to convert sunlight directly into chemical energy, driving essential chemical reactions such as H_2 generation from water splitting, CO_2 reduction, and pollutant degradation [1].

Dion-Jacobson-type layered perovskites are effective semiconductors for sustainable photocatalytic processes owing to their robust structural stability, charge separation, and tailorable optoelectronic properties.

This study focuses on the synthesis, structure, and properties of perovskite-related layered transition oxyhalides of the type (MCl)$LaTa_2O_7$ (M = Co, Fe), along with their assessment for sustainable photocatalytic processes.

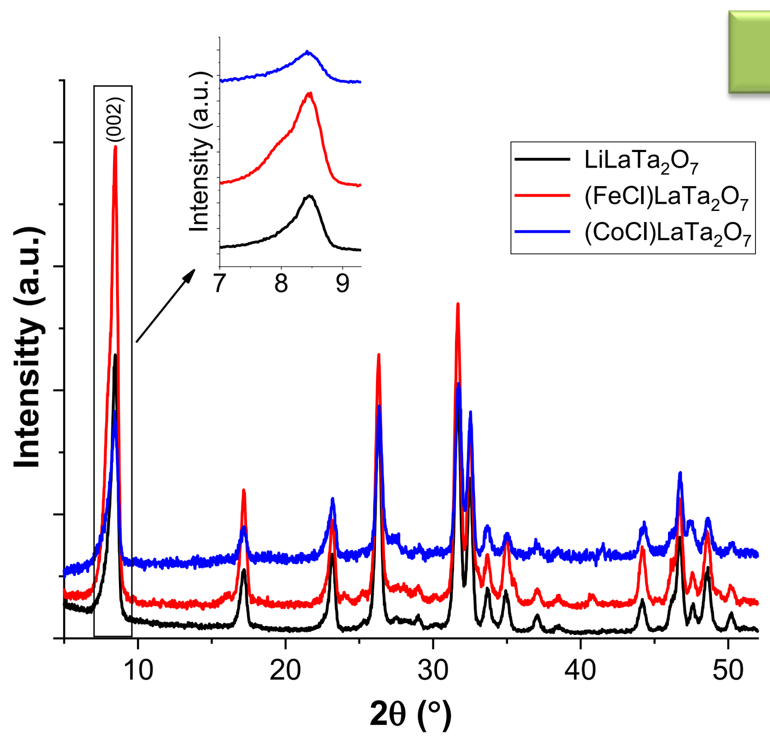
METHOD

Synthesis of (FeCl)$LaTa_2O_7$ and (CoCl)$LaTa_2O_7$ samples



RESULTS & DISCUSSION

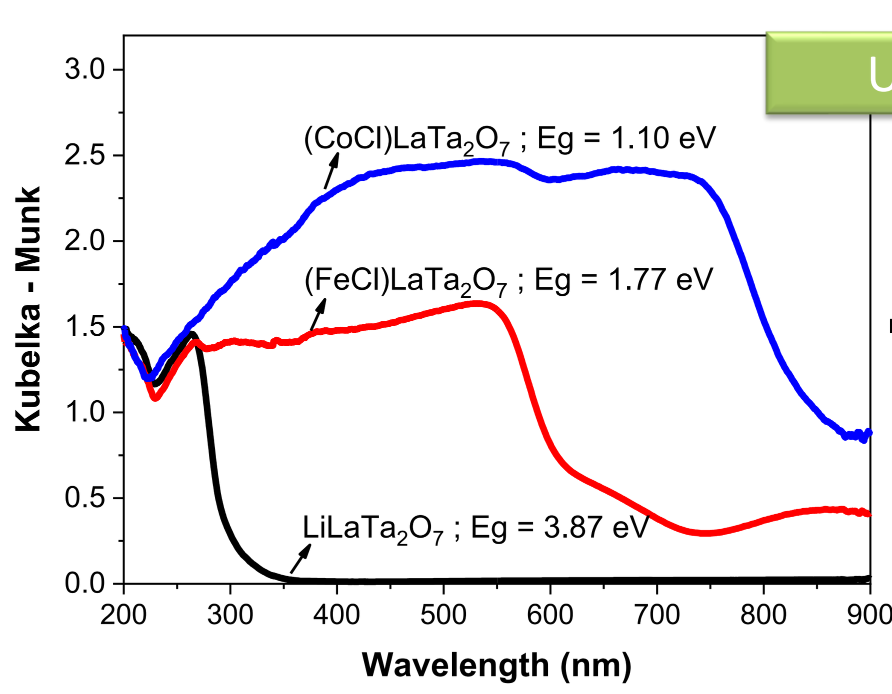
XRD



Sample	Lattice parameters	$d_{(002)}$
$LiLaTa_2O_7$	a = 3.884 Å c = 20.472 Å	10.435 Å
(FeCl)$LaTa_2O_7$	a = 3.882 Å c = 20.473 Å	10.431 Å 11.127 Å
(CoCl)$LaTa_2O_7$	a = 3.885 Å c = 20.463 Å	10.426 Å

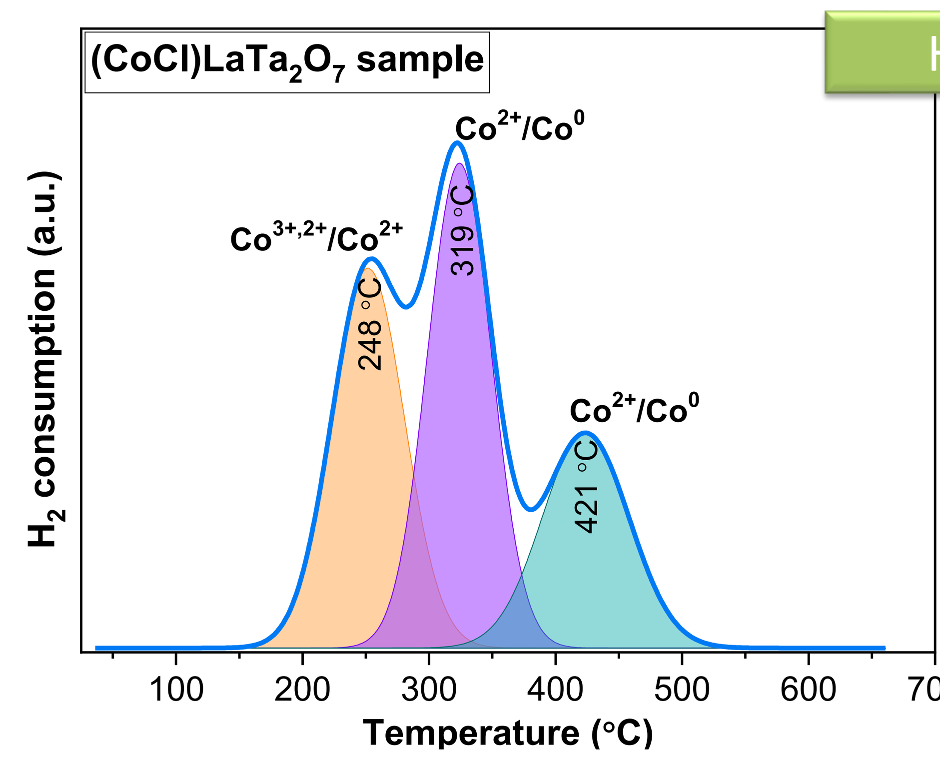
- (002) reflections shifts in accordance with the intercalated species → basal spacing increases for $(FeCl)^+$ intercalation into the perovskite layers;
- (110) plane does not change → the Tetragonal structure was maintained.

UV-Vis



- Decrease of the energy band gap after Fe^{2+} and Co^{2+}-modification of $LiLaTa_2O_7$ layered perovskite

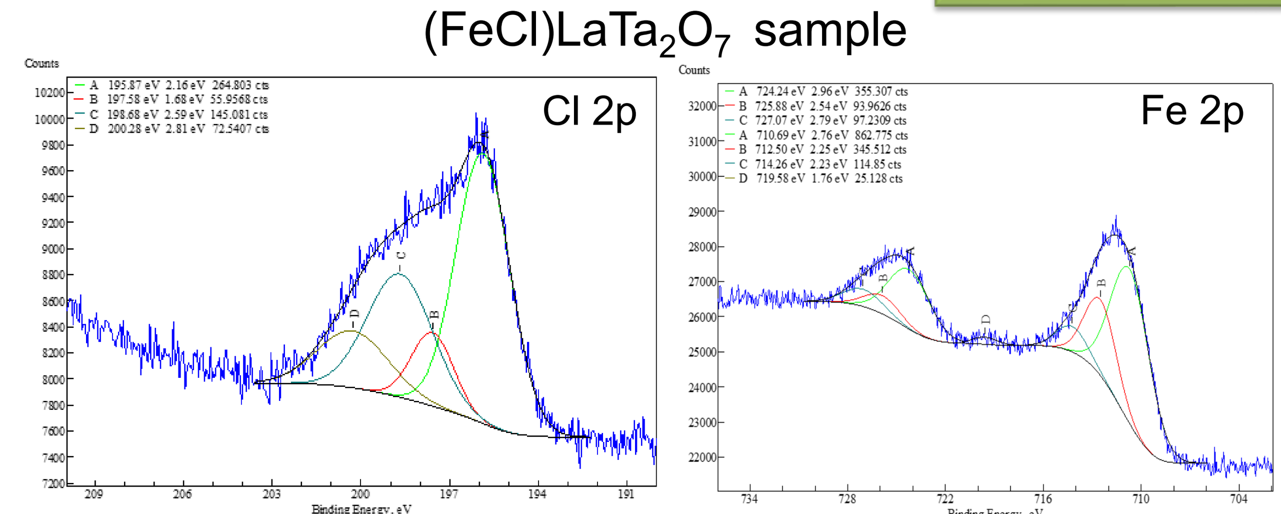
H_2-TPR



- Reduction of cobalt at low temperature corresponding to surface $Co^{3+,2+}$/ Co^{2+} (248 °C) and Co^{2+}/Co^0 species (319 °C);
- At T > 400 °C, Co^{2+} species between the layers are reduced.

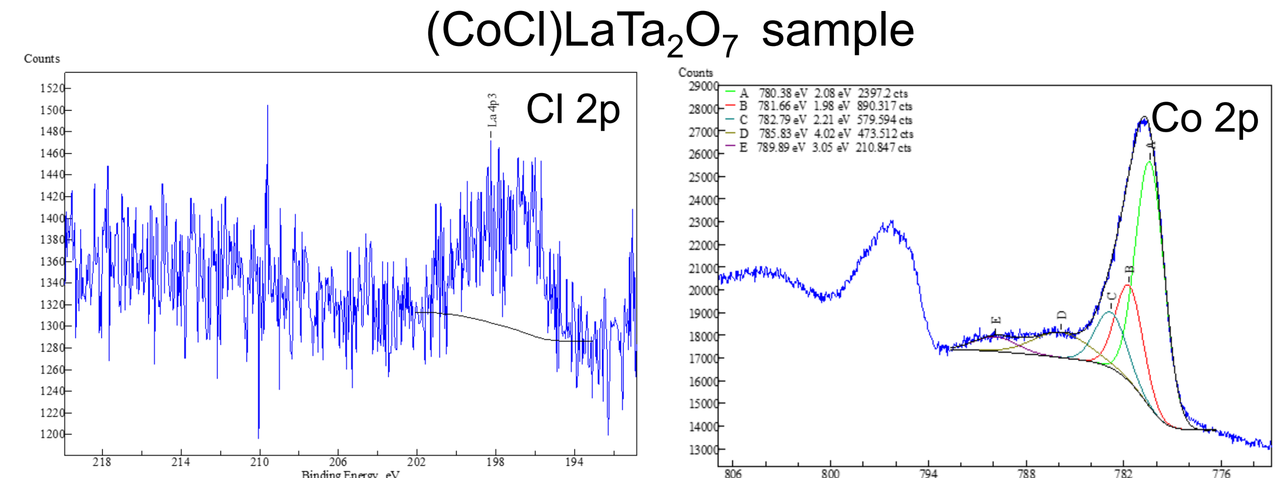
XPS analysis

(FeCl)$LaTa_2O_7$ sample



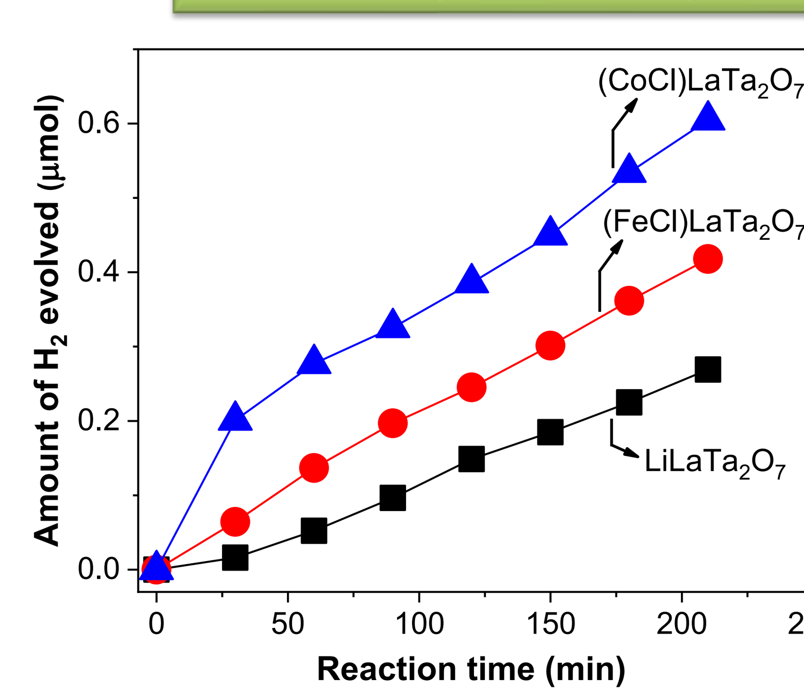
- Intercalation of $(FeCl)^+$ species.

(CoCl)$LaTa_2O_7$ sample



- Weaker $(CoCl)^+$ insertion processes had taken place.

Photocatalytic water splitting in the absence of a sacrificial agent



- H_2 evolution:

$LiLaTa_2O_7$ < (FeCl)$LaTa_2O_7$ < (CoCl)$LaTa_2O_7$

Reaction conditions: 0.050 g of catalyst; 110 ml pure water; 3 ml/min Ar flow; Xe lamp irradiation

CONCLUSION

- $LiLaTa_2O_7$ was successfully ion-exchanged with transition oxyhalides to yield (FeCl)$LaTa_2O_7$ and (CoCl)$LaTa_2O_7$ layered materials;
- $LiLaTa_2O_7$ undergoes noticeable structural changes in the presence of $FeCl_2$ with a large increase of the basal spacing ;
- A significant decrease in the energy band gap was noticed after adding oxyhalides into $LiLaTa_2O_7$;
- (FeCl)$LaTa_2O_7$ and (CoCl)$LaTa_2O_7$ acts as potential photocatalysts for photocatalytic water splitting.

REFERENCES

[1]. K. Chen *et al. J. Environm. Chem. Eng.*, 2025, *13(5)*, 117529.