Catalytic activity of doped $SrFeO_{3-\delta}$ perovskite-type oxide ceramics for degradation of water pollutants

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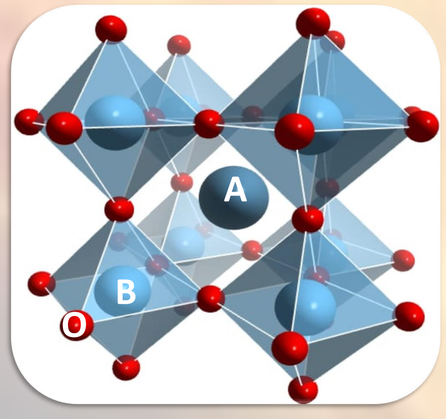
INTRODUCTION AND AIM OF WORK

Cerium-doped strontium ferrate with formula $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ is a mixed oxide with **perovskite-type** structure.



Perovskites have the general formula **ABO_3,** where : **A** – large alkali-earth or rare-earth cations, **B** – small transition-metal cations, **O** – oxygen.

The structure is **cubic**, although the un-doped $SrFeO_3$ is not [**1, 2**]. In addition, both **Fe^{4+}** and **Fe^{3+}** are present at the **B-site**, and this **redox couple** is responsible for most of the properties of this compound [**2, 3**]

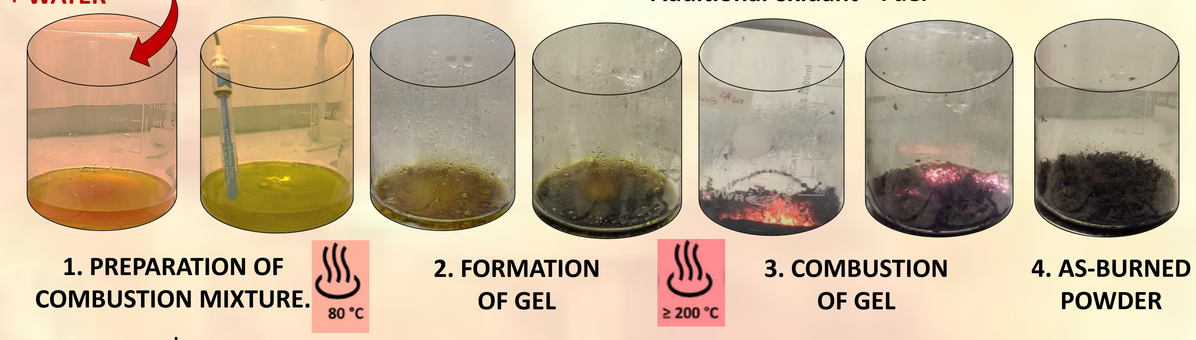
It has been demonstrated that $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ prepared by solution combustion synthesis has some activity in the thermo-catalytic degradation of Orange II [**4**].

In this work, we **investigated thermo-catalytic properties of $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ for the degradation of Bisphenol A** (BPA).

The powder was prepared by **solution combustion synthesis**, which is a sustainable approach, due to **short duration of the procedure** and to the **high purity** and **high porosity** of the obtained powder [**5**].

SOLUTION COMBUSTION SYNTHESIS

$$0.85\ Sr(NO_3)_2 + Fe(NO_3)_3{\cdot}9H_2O + 0.15\ Ce(NO_3)_3{\cdot}6H_2O + 11.56\ NH_4NO_3 + 4\ C_6H_8O_7 \rightarrow Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$$

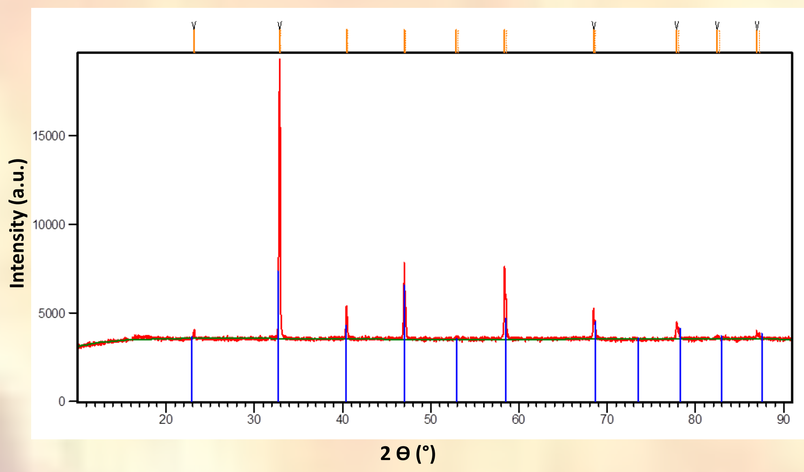


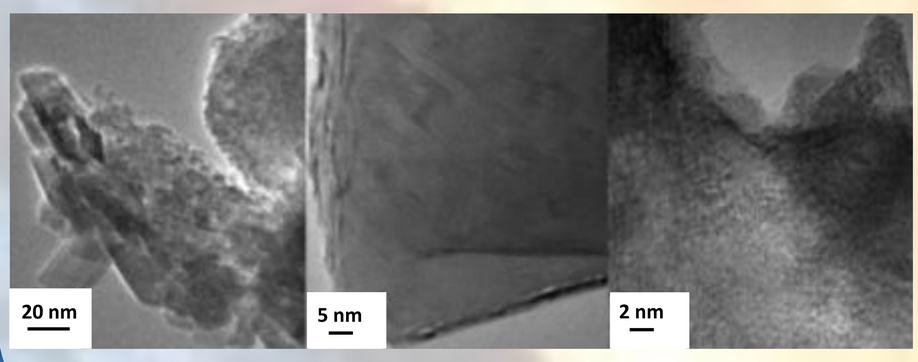
Based on a previous work [2], **reducers-to oxidizers ratio (Φ)** has been chosen **equal to 1** to obtain a stoichiometric ratio with balanced reducing and oxidizing species. As-burned powder was calcined in **1000°C** for 5 h with heating rate of 5°C/min.

STRUCTURAL AND MICROSTRUCTURAL PROPERTIES

From the analysis of the **XRD pattern** it can be seen that the main phase formed is the **cubic** perovskite $SrFeO_{3-\delta}$.

Obtained **crystallite size** value was **132 nm**, close to the one obtained by Tummino *et al.* [4].





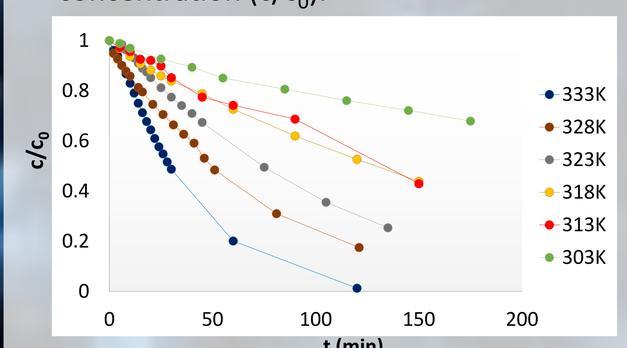
TEM images show the presence of **elongated and roundish aggregated particles** of **variable size** [4].

From the analysis of the fringe patterns the system was found to be **extensively crystalline** [4].

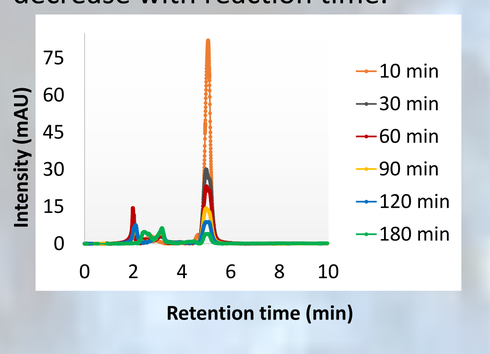
KINETIC STUDIES

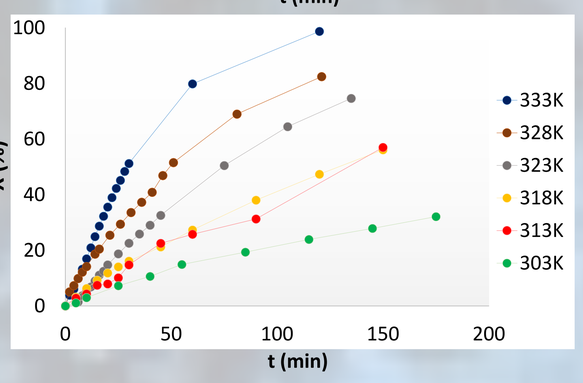
We studied the **effect of temperatures** (303-333K) **on degradation of BPA** (c_0=10 mg/l) with addition of $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ (c=0.5 mg/ml) **in time**.

The higher the temperature the lower the ratio of concentration in time/initial concentration (c/c_0).



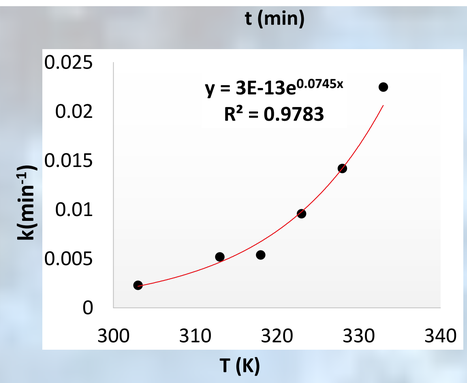
Intensity of HPLC chromatographs decrease with reaction time.



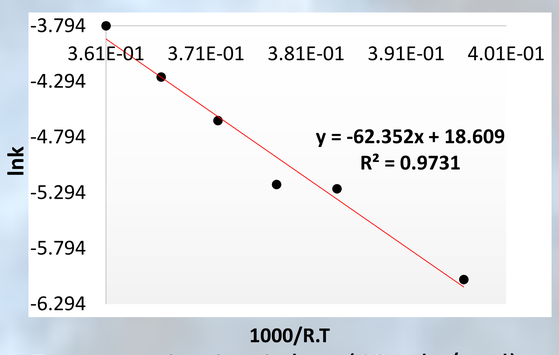


The higher the temperature the higher the degradation rate X (%) of pollutant BPA.

At 333K almost 100% degradation rate of BPA was observed after 120 min.



Kinetic rate increases with the increasing of reaction temperature.



Energy activation is low (62.4 kJ/mol) due to catalyst addition.

CONCLUSIONS

- Perovskite-type cerium-doped strontium ferrate with formula $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ is a **high-efficient, environmental friendly and low-cost single-phase crystalline** catalyst for the BPA degradation.
- Significantly **higher catalytic activity** of $Sr_{0.85}Ce_{0.15}FeO_{3-\delta}$ was observed **with increase of temperature.**
- **It is low energy-consumption technology**. Alternative heating sources, such as solar light or heat from process streams can be used to heat the solution and degrade pollutants.
- **This ceramic catalyst can be a promising material for the effective removal of contaminants in water purification application.**

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