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Innovative and flexible synthesis of Strontium Titanate nanoparticles with new composition in supercritical water/ethanol mixture

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Strontium titanate (SrTiO_3) has emerged as a material of significant interest due to its exceptional properties and versatile applications across various scientific and technological domains. Its unique combination of electrical, optical, and catalytic properties, along with its high chemical stability, has positioned SrTiO_3 as a promising material for a wide range of applications [1].

One of its main features is the possibility of having its physical properties tuned by the doping of elements, which can lead to the enhancement or decline of its electronic properties. As an example, it is frequently used as a component for multilayer ceramic capacitors [2] but it can also be used in thermistors, gas sensors, and catalysts.

Currently, extensive research is conducted on perovskite (ABO_3) catalysts as the preferred material for oxidative coupling of methane (OCM) [3]. In order to meet the requirements for an application of advanced high-temperature electrolysis (HTE) based on the electrolysis of water and CO_2 and their combined conversion into hydrocarbons, it is essential to have a material presenting mixed ionic and electronic conductivity (MIEC).

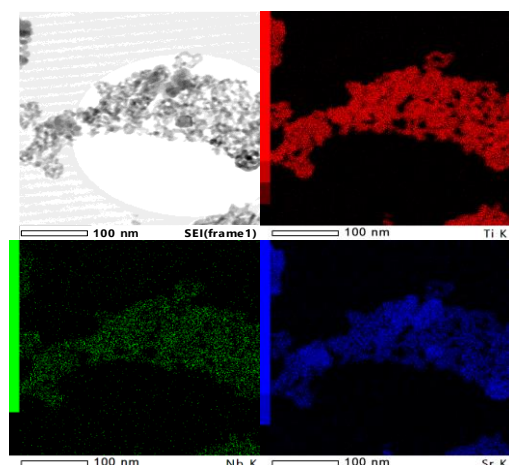


Figure 1. EDS picture of SrTiO_3 doped with Niobium with the Sr element in red, Ti element in blue and Nb element in green.

ICMCB mastered the combination of multi-cationic oxide synthesis and supercritical continuous solvothermal synthesis, leading to compounds never synthesized before using the technique. Deep studies of the accessible substitutions in solid solutions - on the: i) A site, in this case barium with strontium (BST) and ii) B site, in this case titanium with zirconium (BTZ) - have been conducted since the first synthesis of BaTiO_3 (BT) using this approach with alkoxide precursors [4,5]. Recently, a new synthesis route based on the use of acetylacetonate has been developed, leading to the successful synthesis of undoped and doped Strontium Titanate.

This communication focuses on the synthesis of high-quality SrTiO_3 nanocrystals doped and co-doped on A and B sites with various atomic percents (5% and 10%) and elements (Nb, Y, and Fe), showing the flexibility of supercritical continuous flow conditions.

We will detail the physicochemical characterizations of the produced particles and the influence of the doping on their electronic properties. These observations will be discussed using numerous characterization techniques, such as X-ray diffraction, Raman spectroscopy, ICP-OES, and HRTEM. To summarize, an optimization of the synthesis using the never-before-used precursors allowed us to synthesize new multi-cationic compounds, which is a first in supercritical continuous solvothermal synthesis.

References

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