# TEMPERATURE AND ATMOSPHERE INFLUENCE DURING COMBUSTION SYNTHESIS OF METAL OXIDE (NANO)POWDERS

Author: Robert IANOȘ

## Abstract

The habilitation thesis titled "Temperature and atmosphere influence during combustion synthesis of metal oxide (nano)powders" summarizes the most important scientific achievements published by the candidate after defending his PhD thesis in 2008. The research activity conducted by the candidate is mainly focused on the preparation of metal oxide (nano)powders via solution combustion synthesis.

Within this research field, the candidate has opened new perspectives by suggesting a number of innovative solutions to adjust and control the temperature and the atmosphere during combustion reactions, but also to remove the residual carbon by hydrogen peroxide, $H_2O_2$, treatment. The feasibility and the efficiency of these approaches, presented in this habilitation thesis, have been recognized and validated by the international scientific community, as the obtained results have been published in prestigious ISI-ranked journals.

The superiority of the solutions suggested by the candidate enabled the combustion synthesis of a wide variety of materials, such as metal oxides, oxide compounds, oxide solid solutions and even composite materials: γ-$Fe_2O_3$ (maghemite), $Fe_3O_4$ (magnetite), $LaAlO_3$ (lanthanum aluminate), $CaZrO_3$ (calcium zirconate), $ZnAl_2O_4$ (zinc aluminate), $CoFe_2O_4$ (cobalt ferrite), $BaAl_2O_4$: $Eu^{2+}$, $Dy^{3+}$ (barium aluminate doped with europium and dysprosium), $Fe_3O_4$/C (magnetite/carbon composites).

Unlike many of the synthesis methods, which require an annealing step in order to obtain the desired crystalline compound, combustion synthesis has several advantages: it doesn't require annealing, is time and energy efficient, and last but not least is environmentally friendly. An additional advantage is that powder characteristics (surface area, crystallite size and grain size) prepared by combustion synthesis can be properly adjusted by changing the synthesis conditions.

From this point of view, the candidate points out that the most important parameters, namely temperature (higher or lower) and atmosphere (oxidizing or reducing) during the exothermic combustion reactions can be controlled, which is of vital importance especially in the case of metal oxides containing cations which may adopt several numbers of oxidation.

The major role of temperature developed during the combustion reaction is discussed in the case of $LaAlO_3$, $CaZrO_3$, $ZnAl_2O_4$ and $CoFe_2O_4$ powder preparation. The importance of carrying out combustion reactions under reducing atmosphere is a major key in the case of $Fe_3O_4$ and $BaAl_2O_4$: $Eu^{2+}$, $Dy^{3+}$ powders. The final part of the main section presents an efficient solution to remove the carbon impurities from $ZnAl_2O_4$ or γ-$Fe_2O_3$ samples prepared by combustion synthesis, namely chemical oxidation with hydrogen peroxide, $H_2O_2$. From the point of view of the influence of the procedure followed for residual carbon elimination on the main characteristics of $ZnAl_2O_4$ and γ-$Fe_2O_3$ powders, namely particle size and specific surface area, the removal of the residual carbon by hydrogen peroxide treatment is a superior technique to the conventional annealing.

The full abstract at:
http://www.upt.ro/img/files/2014-2015/doctorat/abilitare/ianos/Rezumat_teza_Robert_Ianos_RO.pdf

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Prof.univ.dr.ing. Rodica PODE
Universitatea Politehnica Timișoara;
Academician dr. Maria ZAHARESCU
Institutul de Chimie Fizică al Academiei Române "Ilie Murgulescu";
Prof.univ.dr.ing. Adelina IANCULESCU
Universitatea Politehnica București.