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MATERIALE CERAMICE CU STRUCTURĂ PEROVSKITICĂ: DE LA SINTEZĂ LA APLICAȚII

REZUMATUL TEZEI DE ABILITARE

CANDIDAT:
CS I Dr. Sfîrloagă Paula
UNIVERSITATEA DE VEST DIN TIMIŞOARA
FACULTATEA DE CHIMIE, BIOLOGIE, GEOGRAFIE

CERAMIC MATERIALS WITH PEROVSKITIC STRUCTURE: FROM SYNTHESIS TO APPLICATIONS

Abstract of the HABILITATION THESIS

The habilitation thesis entitled "CERAMIC MATERIALS WITH PEROVSKITIC STRUCTURE: FROM SYNTHESIS TO APPLICATIONS", briefly presents the research activity carried out after the defense of the doctoral thesis: "Study of the process of obtaining, characterizing and testing the bactericidal effect of zeolitic materials functionalized with titanium dioxide " (2010). The research was carried out within the Timișoara National Research and Development Institute for Electrochemistry and Condensed Matter.

The thesis is structured in three parts: Section I, in which the main professional and scientific achievements are presented, Section II, dedicated to the Professional and Scientific Career Development Plan, and Section III, presents the list of the 164 bibliographic references consulted.

In the first part of Section I, the most representative works that support the content of the habilitation thesis from the 104 ISI indexed scientific articles published in the post-doctoral period are presented. Thus, general aspects of perovskite materials, synthesis methods used to obtain functional structures and their applications are presented.

Perovskite materials are among the most promising materials with applications in a variety of modern technologies, such as: renewable energy sources, energy storage and pollutant degradation, sensors, due to their sensitive and selective properties. Although perovskite oxides (ABO_3) exhibit an ideal cubic structure in reality, they can have several other crystal structures due to structural distortions. The crystal structure of these compounds is mainly due to the tilting of the BO_6 octahedra (treated as rigid species) around one or more crystallographic directions. The perovskite structure can be suitably modified by incorporating metal or non-metal ions with different sizes and charges. These materials have high structural stability, and the A and/or B cation can be partially or totally substituted with another cation having a different oxidation state or ionic radius, so that the oxidation state of the B cation and the free oxygen content can be controlled.

Taking into account the above, the perovskite materials were synthesized by the sol-gel method and by the ultrasonic method with the immersed sonotrode in the reaction medium. The data obtained by different analysis and characterization techniques (XRD, FT-IR, UV-Vis, BET, SEM, TEM) confirmed the obtaining of well-crystallized structures, without secondary phases. Also, using different dopants (metallic or non-metallic), the electrical, electrochemical and photocatalytic properties of the perovskite materials were studied.

Using complex impedance measurements, the electrical conductivity σ of the samples was determined and the results showed that it obeys Jonscher's universal law. Furthermore, electrical measurements were performed at different temperatures, between 30 ºC and 120 ºC, in the frequency range 20 Hz–2 MHz. Electrical measurements also showed that the σ values were influenced by both the dopant and its concentration.

Photocatalytic studies proved the potential for water purification with perovskite nanomaterials, and the best removal efficiency was achieved in the presence of the LaMnO:Ho structure, when 77% of EE2 endocrine disruptors (e.g., 17α-ethylnylestradiol) were degraded after 30 minutes of UV irradiation.

Electrochemical experiments revealed that N-doped $LaMnO_3$-based perovskites exhibit electrocatalytic activity in the presence of the ferric/ferrous redox couple. The addition of a high nitrogen content can lead to a high capacitance value, an improvement in the electroactive surface of the electrode, and also an increase in the apparent diffusivity of ferricyanide ions.

To carry out a comparative study, the perovskite materials were functionalized with clay minerals (Montmorillonite K10). The obtained hybrid materials were electrochemically woven, obtaining modified electrodes. The measurements showed an improved HER catalytic performance with applicability in the field of water splitting.

In SECTION II of the habilitation thesis, the main prospects for professional, scientific and academic career development are presented.