

ANNOTATION

1) Title of the dissertation research

The dissertation by Sovet Aigerim Berikkyzy is devoted to the topic «Synthesis and investigation of high-temperature superconducting composites for aerospace applications».

2) Aim of the dissertation research

The aim of the research is to synthesize YBCO based composites with enhanced high-temperature superconducting properties adapted for aerospace applications, and to comprehensively investigate their structural-phase, morphological, and electrophysical characteristics.

3) Research objectives

To achieve the stated aim, the following scientific objectives were defined:

- to investigate the influence of the stoichiometry of the initial components, sintering temperature, and holding time on the formation of the YBCO superconducting phase;
- to determine the effect of mechanical activation parameters on the phase composition and microstructure of YBCO composites;
- to analyze the influence of doping with aluminum, iron, and nickel microparticles, as well as carbon nanotubes, on superconducting properties (critical temperature and critical current density);
- to evaluate the structural and superconducting characteristics of the obtained composites in terms of material requirements for aerospace power systems;

4) Research methods

The study employed a combination of general scientific and modern experimental methods. Superconducting composites were fabricated using the solid-state synthesis method, while mechanical activation was applied to enhance reaction kinetics.

The structural-phase composition of the samples was examined by X-ray diffraction (X-ray Diffraction), and the microstructure was analyzed using scanning electron microscopy (Scanning Electron Microscopy). Thermal stability and phase transformations were investigated by thermogravimetric and differential thermal analysis (TG/DTA).

Superconducting properties, including critical temperature and electrical characteristics, were measured using a Physical Property Measurement System (PPMS). Experimental data were processed based on comparative analysis and reproducibility principles, ensuring the reliability of the obtained results.

5) Main scientific statements

The dissertation substantiates the following main scientific statements:

- optimization of solid-state synthesis and mechanical activation parameters accelerates the formation of the YBCO superconducting phase and increases phase purity;
- doping with aluminum microparticles within an optimal concentration range improves the structural stability of YBCO composites and contributes to an increase in the critical temperature;
- excessive addition of iron and nickel microparticles enhances the formation of secondary phases and leads to a deterioration of superconducting properties;
- the effect of carbon nanotubes is non-uniform and depends on their concentration, dispersion quality, and interaction with the matrix.

6) Description of the main research results and assessment of their reliability

As a result of the study, optimal technological parameters for obtaining YBCO-based superconducting composites were determined. Optimization of sintering regimes and mechanical activation duration allowed maintaining a high yield of the superconducting phase while reducing the material synthesis time compared to conventional technologies.

In aluminum-doped composites, a stable increase in the critical temperature and improved microstructural uniformity were observed. In systems doped with iron and nickel, a degradation of superconducting properties and the formation of secondary phases were recorded.

The obtained results were confirmed using several independent methods (XRD, SEM, PPMS), ensuring their reliability and reproducibility.

7) Justification of novelty and significance of the results

The scientific novelty of the dissertation lies in the comprehensive identification and analysis of the effects of synthesis parameters, mechanical activation, and micro- and nano-additives on the superconducting properties of YBCO composites.

The proposed approaches substantiate the possibility of producing high-temperature superconducting materials using shortened thermal treatment cycles while maintaining structural stability. These results make a significant contribution to the engineering optimization of cuprate-based superconducting materials.

8) Compliance with scientific development directions and state programs

The research results correspond to priority directions in the development of materials science, aerospace engineering, and energy-efficient technologies. The work aligns with state scientific and technological programs of the Republic of Kazakhstan aimed at advancing aerospace technologies, developing high-tech materials, and improving energy efficiency.

9) Contribution of the doctoral candidate to publications

In all scientific publications resulting from the dissertation research, the doctoral candidate directly participated in experimental planning, sample synthesis, data processing, and scientific analysis of the obtained results. The conceptual framework, experimental part, and main conclusions of the publications were developed with the author's direct contribution. The research results have been published in 8 scientific articles, including 2 papers in journals indexed in the Scopus database, 1 article in a journal recommended by the Committee for Quality Assurance in Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan, and 5 papers in the proceedings of international and national conferences.

The dissertation structure includes an introduction, three chapters, a conclusion, and a list of references. The total volume is 120 pages and contains 42 figures, 20 tables, and 133 references.