The results of the studies can be used to calculate the plasmachemical synthesis of complex oxide compositions for dispersion nuclear fuel.

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COMPARISON OF Y_2O_3 AND ZrO_2 SYNTHESIZED FROM WATER NITRATE SOLUTIONS AND WATER-ORGANIC NITRATE SOLUTIONS

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One of the priorities in the development of modern material science is the technology based on nanosized powders, which is due to the desire for miniaturization of products, unique properties of materials in the nanostructured state, etc.

The most common technologies for producing such nanosized oxides are laser sublimation, chemical precipitation from solutions, hydrothermal method and sol-gel technology. Each method has its advantages and disadvantages, while the choice of technology is determined by the purpose of the powder, the state of its microstructure, method performance, complexity and cost of the equipment used. The disadvantages of the methods used to obtain nanosized powders include: multi-staging, long process duration, low productivity, the need to use a large number of chemicals, non-uniform distribution of phases in the powders, and high cost.

Taking into account above, the use of low-temperature plasma is promising for obtaining nanosized metal oxide powders. The advantages of plasma-chemical synthesis from water nitrate solutions (WNS) include: one-staging, high process speed, homogeneous phase distribution with a given stoichiometric composition, the ability to actively influence the size and morphology of particles, and the compactness of technological equipment. However, plasma treatment of only WNS due to high energy costs (up to 4.0 kW·h/ g) [1] is not widely used, and it is possible to significantly reduce energy consumption and increase productivity by introducing an organic component in the composition of the initial WNS.

Firstly, the optimal compositions of water-organic nitrate solutions (WONS) based on acetone and WNS $Y(NO_3)_3$, as well as acetone and WNS $ZrO(NO_3)_2$ were calculated. For this, the values of lower calorific value were determined for various mass fractions of acetone in WONS. Secondly, in order to determine the optimal modes of the process under study, the influence of the mass fraction of the air plasma coolant on the adiabatic combustion temperature of WONS was determined.

The studies were carried out using plasma module based on the high-frequency generator. For plasma treatment, WONS-1 and WONS-2 were prepared according to the optimal compositions determined for them, while the concentration of $Y(NO_3)_3$ and $ZrO(NO_3)_2$ salts was 97 g/100 ml of water and 57 g/100 ml of water, respectively. The prepared solutions were processed in a high-frequency torch plasma. During the plasma treatment, after liquid evaporation and crystallization of the salt, yttrium and zirconium oxides were formed as a result of thermolysis, which were quenched in centrifugal bubblers. The obtained oxide powders were sent for analysis.

To study the main parameters of the obtained powders, scanning electron microscopy, BET analysis, and X-ray phase analysis were performed. The obtained results were compared with data [3] on the parameters of yttrium and zirconium oxide powders obtained by plasma-chemical synthesis from WNS (without the addition of an organic component). From the analysis of the presented data, it follows that the powders obtained by plasma-chemical synthesis from WONS-1 and WONS-2 are comparable in a number of parameters (CSR size, specific surface area) with powders obtained by plasma-chemical synthesis from WNS solutions. However, zirconia powders obtained by plasma-chemical synthesis from a WONS-2 solution are in the tetragonal and cubic phases, and obtained from WNS in the monoclinic phase, which is explained by the use of quenching in the first case. In this case, the inclusion of the organic component in the composition of the WNS leads to an increase in powder productivity by 2.5–4 times and a decrease in energy consumption for producing 1 kg of nanosized powders by 5–8 times.

Considering the obtained results, it can be argued that the plasma-chemical synthesis of yttrium and zirconium oxides is an energy-efficient method for producing nanosized powders, which can be used to obtain oxide nanosized powders of other metals.

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