Synthesis of Ultrafine Copper Oxide Powder with Plasma-dynamic Method in the Coaxial Magneto-plasma Accelerator

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Abstract—**One of the most promising trends in modern physics is the high-temperature superconductivity. Analysis of high-temperature superconductors revealed that almost all of them are complex copper-based oxides. Studies have shown the possibility of using them for the synthesis of coaxial magneto accelerator. Studies have identified the products synthesized soot: Cu, Cu_2O, CuO, their shape and size. Also been deciphered and electron microscopy confirmed the composition of the nanopowder obtained in laboratory conditions.**

Keywords-high-temperature superconductivity; copper oxide; magnetic plasma; nanomaterials; energy conservation; energy.

I. INTRODUCTION

Today superconductivity is one of the most promising areas of physics which generates interest of many scientists. However, practical application of high-temperature superconductors is largely limited by the technology.

Literature review shows that currently superconductivity in cuprates results from the copper-oxygen layer where copper atoms form a square grid. Copper atoms are located at grid points, while oxygen atoms are on the lines connecting these points. [1][2]

II. COAXIAL MAGNETO-PLASMA ACCELERATOR

Ultrafine copper oxide powder was synthesized in the coaxial magneto-plasma accelerator designed by TPU scientists. [5] This accelerator technology can be used to accelerate plasma to hyperspeed.

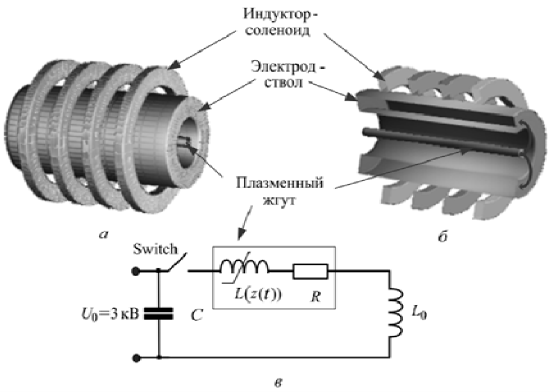

Figure 1. Simplified model of coaxial magneto-plasma accelerator: a) conductive part; b) cross-section; c) electrical circuit [6]

The accelerator is designed as a coaxial shaft-electrode system separated by an insulator and placed inside the solenoid. The shaft is cylinder-shaped. On closing the key current flows from the capacitor bank via solenoid coils, passes through the shaft and central electrode to the capacitor through the switch.

Arc discharge results from the insulator surface breakdown.

Plasma is compressed by the intrinsic current magnetic field and by the solenoid magnetic field and is shaped as piston.

The generated jet impinges into the reactor chamber, where the material is sputtered off the electrode surface, and nanosized particles are formed.

III. EXPERIMENTATION

TABLE 1. EXPERIMENTAL CONDITIONS FOR THE SYNTHESIS OF ULTRAFINE COPPER OXIDE POWDER WITH COAXIAL MAGNETO-PLAZMA ACCELERATOR.

plasma	Cu
Medium	Air
Charging voltage	3kV
capacity	12 mF
electrode	Steel + copper tip

IV. OUTPUT EVALUATION

Following the experiment X-ray microscopy of the obtained ultrafine powders was made. Full-profile X-ray analysis PowderCell package and structural data base PDF 4 + were used.

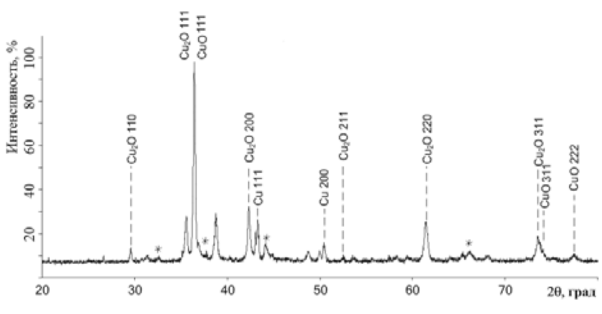

Figure 2. X-ray diffraction analysis

The next synthesized powder phases were registered:

- copper oxide (I) (Cu_2O) - 3,5%
- copper oxide (II) (CuO), exhibiting the highest rate(nearly 85%)

- pure copper (Cu) (nearly 8%)
- impurity phases, presented on radiographs as implicit peaks marked with an asterisk (*) - about 4%. Their presence in the synthesized powder could be explained by the fact that the target material used in the experiment is aluminum. During the experiment erosion occurred when melting in the plasma jet. Therefore, aluminum oxide (Al_2O_3) is one of the fusion products.

Transmission electron microscopy data were also obtained and interpreted. [7]

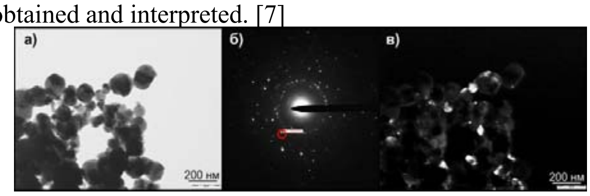

Figure 3. Transmission electron microscopy results: a) bright field image; b) Electron diffraction pattern on the selected area; c) dark-field image

Bright field image allowed identifying particle morphology. The particles form a convex polygon with rounded corners. Their size varies from 80 to 150 nm. Lighter, circular shaped particles are copper oxides. Darker, angular shaped ones are copper.

According to the electron diffraction pattern for the selected area it has been determined that the rubricated area is the crystallographic copper phase. Dark-field image was obtained when shifting the aperture diaphragm to the selected reflex point area representing crystallographic copper phase.

As the result of the study electron microscopy was interpreted. The composition of the nanopowder, obtained in laboratory conditions, was confirmed and its phases were defined.

V. Conclusion

The practical task is to obtain nanopowders with a small percentage of impurities and to increase the synthesis reproducibility. The method described meets these requirements. In future, we plan to obtain copper oxide using a coaxial magnetoplazma accelerato synthesize complex high-temperature superconducting materials.

Acknowledgements

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