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The features of High-k hollandite-like ceramics doping by copper

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Abstract

Holland-like complex oxides Ax(Ti,M)8O16 (A is a non-framework cation and M is a transition metal substituting for Ti4+ in the framework) are characterized with high polarizability due to mobility of alkaline ions, incorporated into the 1-D channels, and variable valence of the transition metals.These structural features allows considering hollandite-like solid solutions as alternatives to the non-ferroelectric perovskite-like Ceramic materials ($CaCu_3Ti_4O_{12}$ and $Ba(Fe_{0.5}Nb_{0.5})O_3$) exhibiting high (ε~104) values of the dielectric constant in a wide temperature and frequency ranges. However, the traditional methods used to produce the hollandite-like solid solutions are complicated. In this report, we present a two-stage technology for the synthesis of hollandites in the K_2O-CuO-TiO_2 system. This methodology is based on a use of the amorphous potassium polytitanate, modified in aqueous solutions of copper salts as a precursor material.A presence of well-developed internal surface of layered PPT flakes allows introducing the transition metal ions directly into the structure of the precursor material. The optimal experimental conditions of the chemical treatment (pH, concentration of the aqueous solution, PPT doses) as well as the following thermal treatment (thermal regimes) which allow producing copper-containing hollandite-like potassium titanates were determined. In this regard, the method to produce sintered at 1000-1100 °C ceramics based on hollandite-like powdered solid solutions was proposed and the electric properties of the obtained ceramic specimens were investigated in the frequency range from 1 MHz to 0.1 Hz. The dielectric constant and tangent of dielectric losses for the ceramic samples calcined at 1075 °C were of 104-105 and 0.2-0.9, respectively.The synthesized material can be used as for the production of ceramic dielectrics as high-k ceramics filled polymer-matrix functional composites.This research was financially supported by the Russian Science Foundation (project № 19-73-10133).

Biography:

Nikolay Gorshkov is a PhD,assistant professor of the Department of Materials Chemistry and Chemical Technology (Yuri Gagarin State Technical University of Saratov, Russia). His research interests include solid state ionics (hopping conductivity, multiphase ceramics, electric conductivity, relaxation processes, oxygen vacancies, grain boundary),electrical dielectric materials and composite (impedance and dielectric spectroscopy, conductor, semiconductor, dielectric), methods for producing polymer-matrix composites and nanocomposites.

Speaker Publications:

1. Gorshkov N, Goffman V, Vikulova M, Burmistrov I, SleptsovV,GorokhovskyA (2019) Polytetrafluorethylene-based high-k composites with low dielectric loss filled with priderite (K1.46Ti7.2Fe0.8O16). Journal of Applied Polymer Science 137, 48762.
2. Gorshkov NV, Goffman VG, Vikulova MA, Kovaleva DS, Tretyachenko EV, Gorokhovsky AV (2018) Temperature-dependence of electrical properties for the ceramic composites based on potassium polytitanates of different chemical composition.Journalof Electroceramics 40 (4):306–315.
3. Gorshkov NV, Goffman VG, Vikulova MA, Burmistrov IN, Kovnev AV, Gorokhovsky AV (2018) Dielectric properties of the polymer–matrix composites based on the system of Co-modified potassium titanate–polytetrafluorethylene. Journal of Composite Materials 52(1):135-144.
4. Gorshkov NV, Goffman VG, Khoryukov AS, Sevryugin AV, Burmistrov IN, Gorokhovskii AV (2016) High-Temperature Engineering Ceramic Based on Complex Titanates Having a Hollandite Structure. Refractories and Industrial Ceramics 57(4):1-4.

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