PR-13. HfO_2-BASED FILMS PREPARATION BY CHEMICAL SOLUTION DEPOSITION

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At present HfO_2 and double oxides based on it (HfO_2-M_2O_3, M-REE) are widely studied as optical, heat-resistant and superhard materials, which are of great importance for the development of new technologies. In addition, these materials have a high dielectric constant (k), which opens the possibility of using them as a gate dielectric material in micro- and nanoelectronic devices of a new generation [1]. Hafnium oxide is a structural analogue of zirconium oxide, but it possesses unique chemical resistance even in strongly reducing atmospheres without the appearance of electronic conductivity, therefore electrochemical oxygen sensors can be used in highly reducing environments.

Reducing the electrolyte thickness results in reduction of the ohmic losses across the electrolyte, enhancing simultaneously SOFC's efficiency. That is why thin film technologies are widely applied for fabrication of SOFCs operating at intermediate temperatures [2]. In a SOFC, the electrolyte film must be gas-tight to avoid fuel leakage, while the supporting electrode must be porous enough in order to facilitate gas transport. Deposition of a thin gas-tight film on a porous substrate is one of the challenges, which are to be solved for thin film SOFCs development. A solution that has been suggested consists in the development of a dense layer over a porous electrode surface [3]. Such techniques as physical vapor deposition (PVD), chemical vapor deposition (CVD) and chemical solution deposition (CSD) are used for the fabrication of solid oxide electrolyte films. PVD technologies typically operate at high vacuum; among the PVD methods electron beam deposition, pulsed laser deposition and magnetron sputtering are widespread. CVD methods use a gas-phase precursor; among them plasma enhanced CVD (PECVD), metalorganic CVD (MOCVD), atomic layer deposition (ALD) are exploited for the electrolyte films preparation [4]. The most technologically simple and cheap way to produce dense films of oxide electrolytes is a chemical solution deposition (CSD). The purpose of this study was to obtain dense films based on hafnium oxide by a chemical solution method and investigate their phase composition and microstructure.

The investigated films of solid oxides based on hafnium oxide were obtained from solutions of the salts $HfOCl_2 \cdot 8H_2O$, $Y(NO_3)_3 \cdot nH_2O$ (all with 99,99 % purity) in ethanol.

The solution was applied by vertically dipping the substrates into the solution, followed by drawing at a rate of 0,1–0,2 cm/min. After that, the films were synthesized. The phase composition and morphology of the resulting films were studied by X-ray phase analysis (XRD) and scanning electron microscopy (SEM).

References

1. Growth, chemical composition, and structure of thin $La_xHf_{1-x}Oy$ films on Si / T. P. Smirnova [et al.] // Inorg. Mater. Springer US. 2014. Vol. 50, № 2. P. 158–164.

2. Thin films for micro solid oxide fuel cells / D. Beckel [et al.] // J. Power Sources. Elsevier. 2007. Vol. 173, № 1. P. 325–345.

3. Surface modification of a fuel cell material by ion implantation / A. G. J. Vervoort [et al.] // Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms. North-Holland. 2002. Vol. 190, № 1/4. P. 813–816.

4. Deposition of yttria-stabilized zirconia thin films by atomic layer epitaxy from β-diketonate and organometallic precursors / M. Putkonen [et al.] // J. Mater. Chem. The Royal Society of Chemistry. 2002. Vol. 12, № 3. P. 442–448.

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