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ZIRCONIUM OXIDE STABILIZED BY SCANDIUM (III) AND CERIUM (IV) COMPLEX OXIDES AS THE BASIS FOR PREPARATION OF THICK FILMS AND MULTILAYERS STRUCTURES FOR LOW TEMPERATURE (600 °C) FUEL CELL

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Solid state fuel cells based on film multilayer systems are promising due to their high efficiency, compactness and environmental friendliness. Zirconium matrix stabilized by complex oxides of scandium (III) and cerium (IV), $ZrO_2 - Sc_2O_3 - CeO_2$ have high oxygen conductivity and can be used as solid electrolyte and main component of the anode.

Nanopowders $ZrO_2 - Sc_2O_3 - CeO_2$ were synthesized by precipitation from aqueous solutions. Nanopowders prepared by sequential deposition at optimum pH are weak agglomerated ($K_{filtr} = (0.8 \div 1.5)\times10^{-5}$ cm/sec) and easily laundered, in contrast to the precipitates of the same chemical composition but prepared by co-precipitation ($(2 \div 5)\times10^{-7}$ cm/sec). Weak agglomerated precipitated nanopowders were used for preparation of ceramic samples and thick films by tape casting technique on α-Al_2O_3 substrate. Ceramic samples sintered at 1390-1400°C for 10-12 h were dense (5.45-5.67 g/cm^3) and single-phase with cubic structure. Films were 15÷18 μm in thickness and consist of grains with size of 0.5÷1.5 μm. At 700 °C, the conductivity of thick films was in 2.5÷3 times less than ceramic samples. At the same time, the activation energy for film (1.167 eV) is lower than ceramic (1.344 eV), and difference between conductivity of films and ceramics decreases with decreasing temperature. The oxygen conductivity of thick films was $4\cdot10^{-4}$ S/cm at 600 °C and $2.4\cdot10^{-3}$ S/cm at 700°C; while the electron conductivity was by 2 orders of magnitude lower.

Multilayer system consisting of films of polycrystalline porous anode and solid electrolyte was prepared. It was determined that the use of tannin as additive, laminating, thermal shock (500°C/time) and optimum temperature heat treatment (1100 - 1300 °C) prevents cation diffusion in surface layer of anode film and change in the chemical composition of electrolyte film. Multilayer systems developed can be used for preparation of low temperature (600 °C) fuel cell with film structure.