TEMPERATURE SENSITIVE SPINEL-TYPE CERAMICS IN THICK-FILM MULTILAYER PERFORMANCE FOR ENVIRONMENT SENSORS

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Thick-film performance of spinel-type manganites restricted by $NiMn_2O_4$-$CuMn_2O_4$-$MnCo_2O_4$ concentration triangle has a number of essential advantages, non-available for other ceramic composites. Within the above system, the semiconductor materials with p^+-type ($Cu_{0.1}Ni_{0.1}Co_{1.6}Mn_{1.2}O_4$) and p-type ($Cu_{0.1}Ni_{0.8}Co_{0.2}Mn_{1.9}O_4$) of electrical conductivity can be prepared. The aim of this work is development of the multilayer temperature sensitive thick films based on spinel-type ceramics for possible sensing device application.

Pastes for temperature sensitive thick films were prepared by mixing powders of bulk $Cu_{0.1}Ni_{0.1}Co_{1.6}Mn_{1.2}O_4$ and $Cu_{0.1}Ni_{0.8}Co_{0.2}Mn_{1.9}O_4$ ceramics with some additives of ecologically-pure glass powders (without PbO), inorganic binder Bi_2O_3 and organic vehicle. The prepared pastes were printed on substrates with Ag-Pt electrodes. The scheme of printed integrated thick-film structures is shown in fig. 1. The long-term ageing test at 170 ^oC for one-layer thick films and multilayer structure was carried for study of their reliability. The relative change of electrical resistance ($\Delta R/R_o$) was used as a controlled parameter (R_o– the initial value of electric resistance, ΔR – the absolute change of electric resistance, caused by degradation test). The prepared thick-film elements based on spinel-type $NiMn_2O_4$-$CuMn_2O_4$-$MnCo_2O_4$ ceramics have good temperature-sensitive electrophysical characteristics in the region from 298 to 358 K. They show typical exponential temperature dependence of electrical resistance despite a number of layers. The values of B constants were 3607, 3548 and 3700 K for p-type $Cu_{0.1}Ni_{0.8}Co_{0.2}Mn_{1.9}O_4$ thick-film element, p^+-p and p-p^+-p junctions, respectively. It is shown that degradation processes connected with diffusion of metallic Ag into film grain boundaries occur in one-layer p-conductive films. In two-layer p-p^+-junctions, the increase of electrical resistance during ageing test was observed, whereas three-layer p-p^+-p structures were of higher stability, the relative electrical drift being no more than 1.3 %. Thus, the multilayer thick-film performance allows prepare the high-reliable integrated temperature sensitive elements for environment sensors.

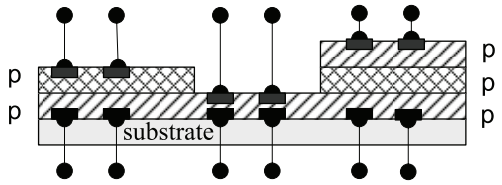

Fig. 1. Topological scheme illustrating integrated spinel-type thick films

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