High-reliable Temperature Systems for Sensor Electronics

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Abstract – **Temperature-sensitive thick-film systems based on spinel-type $NiMn_2O_4$-$CuMn_2O_4$-$MnCo_2O_4$ manganites with p- and p^+-types of electrical conductivity were obtained. All elements are shown good electrophysical characteristics before and after long-term ageing test at 170 ^oC. It is shown that in two-layer p-p^+ systems are typical increases of electrical resistance during ageing test, while three-layer type p-p^+-p structures are high stabile.**

Keywords – **Sensor Systems, ceramics, Thick Films.**

I. Introduction

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, can be prepare 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. The aim of this work is development of the high-reliable temperature-sensitive thick-film systems based on spinel-type ceramics for application in sensor device electronics.

II. Experimental and Results

Thick temperature-sensitive $Cu_{0,1}Ni_{0,1}Co_{1,6}Mn_{1,2}O_4$ and $Cu_{0,1}Ni_{0,8}Co_{0,2}Mn_{1,9}O_4$ pastes for systems were prepared by mixing powders of basic bulk ceramics with ecological glass powders, inorganic binder Bi_2O_3 and organic vehicle [1]. The prepared pastes were printed on substrates with Ag-Pt electrodes. The electrical resistance of temperature-sensitive thick-film structures was measured using temperature chambers HPS 222. The long-term ageing test at 170 ^oC was carried for study of their reliability. The relative change of electrical resistance (DR/R_o) was used as a controlled parameter (R_o– initial value of electric resistance, DR – absolute change of electric resistance, caused by a degradation test). For mathematical description of degradation kinetics, the numerical values of fitting parameters were calculated to minimize the deviation *err* of the experimental points from the relaxation function (RF) as adequate solution of general degradation equation [2].

All obtained temperature-sensitive thick-film systems have good electrophysical characteristics. The values of B constant were 3607 K, 3548 K 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 one-layer and multilayer thick films possess good temperature sensitivity in the region from 298 to 358 K [3].

It is shown that the electrical resistance in p-type thick-film systems incidentally increases in the process of degradation test. It's connected with the compression of thick film and diffusion of metallic Ag into the grain boundaries. The value of DR/R_o is -4-8 %. The degradation kinetics in these thick-films can be described by partly-generalized RF-3 with *err* = 0.025. The p+-p thick-film structures are typical increase of electrical resistance during ageing test with decrease of electrical resistance. The degradation kinetics in these structures can be well described by stretched-exponential RF-4. Indeed, in this case, the low values of *err* = 0.02 are achieved. However, p-p+-p thick-film structures show high reliability after long-term ageing test at 170 ^oC (Fig. 1). The relative electrical drift of this thick-film elements are no more than 1.3 %.

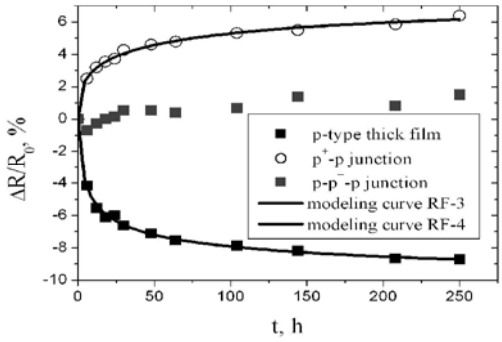

Fig.1. Thermally-induced (170 ^oC) relative resistance drift ($\Delta R/R_0$)

III. Conclusion

The multilayer performance of thick-film elements bring to obtaining of high-reliable systems. The p-type thick film, p+-p and p-p+-p junction can be used as reliable temperature-sensitive systems for application in sensor electronics.

References

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