Combined study of spinel-based thick-film nanostructures

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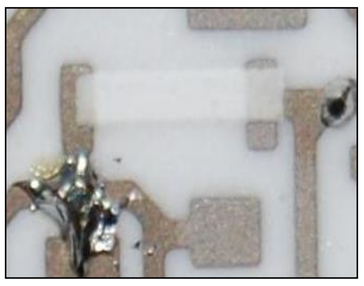
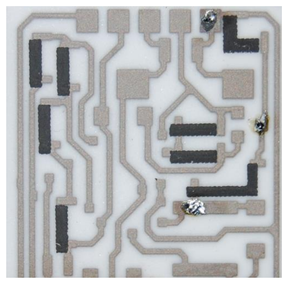
Single- and multilayered thick-film nanostructures based on functional spinel magnesium aluminates and mixed transition-metal manganite ceramics are known to be widely used for temperature and humidity measurement. In this work temperature/humidity sensitive thick films with p^+-type of electrical conductivity, p-type of electrical conductivity, insulating i-type (based on $MgAl_2O_4$ ceramics), as well as *p*-p^+, *p*-p^+-*p* and *p*-*i*-p^+ structures were studied.

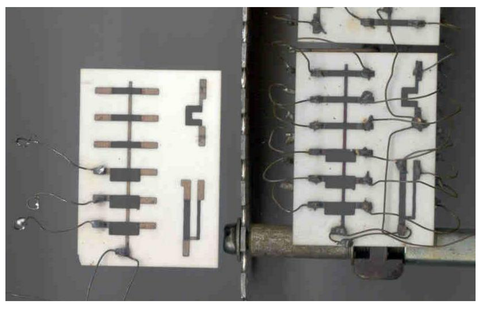
Temperature- and humidity-sensitive thick-film nanostructures

Humidity-sensitive i-type MgO-Al_2O_3

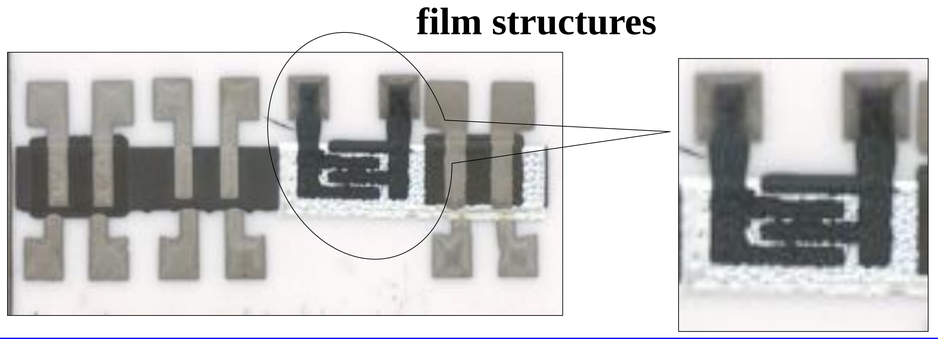


Temperature-sensitive $Cu_{0.1}Ni_{0.1}Co_{1.6}Mn_{1.2}O_4$

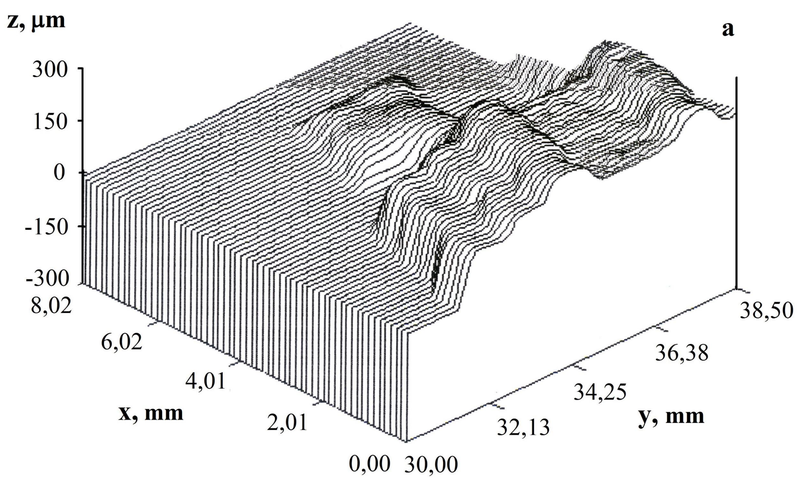


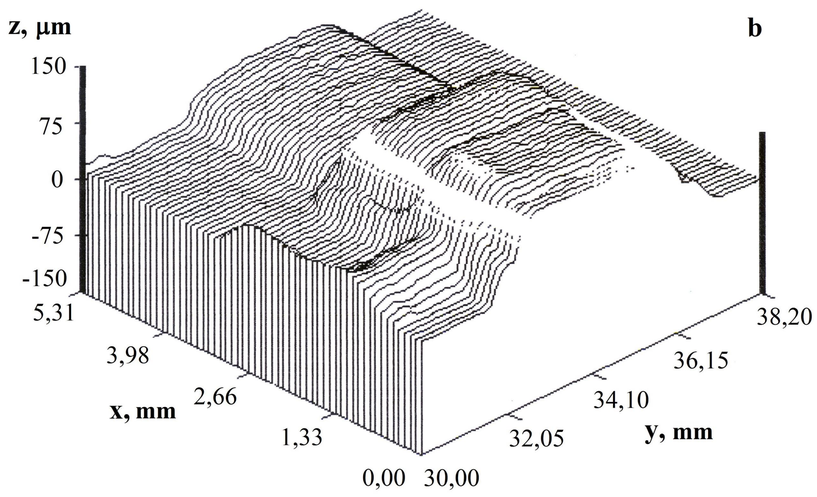


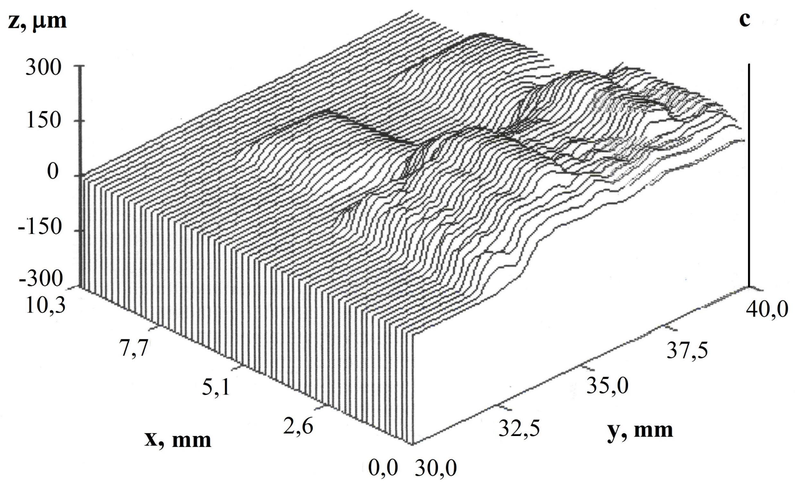
Integrated p-i-p+ temperature- and humidity-sensitive thick-film structures



Topology of thick-film structures



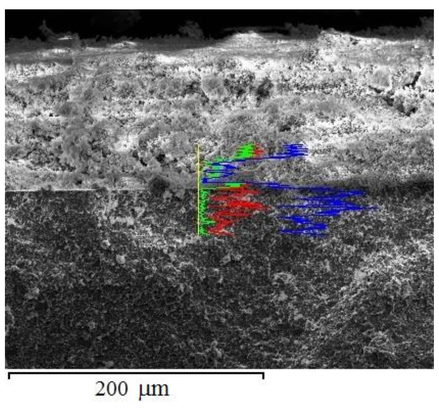


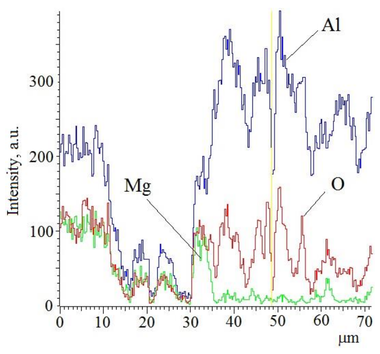


Topology of *p*-p^+ (a), p^+-*i* (b) and integrated *p*-*i*-p^+ (c) thick-film structures

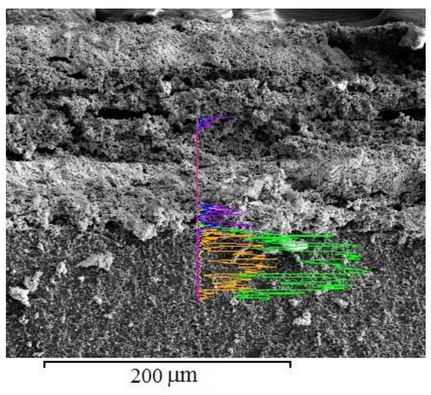
In accordance with results of topological investigations using 3D-profilograph Rodenstock RM600 (Germany), thickness of temperature-sensible p- and p+-layers was 43.75 μm and 46.88 μm, accordingly. The of two-layered p^+-i thick-film structure is 139.06 μm, p^+-p – 110.16 μm, and integrated p-i-p+ thick-film structures with conductive Ag layer – 193.73 μm (thickness of Ag layer is 45.31 μm).

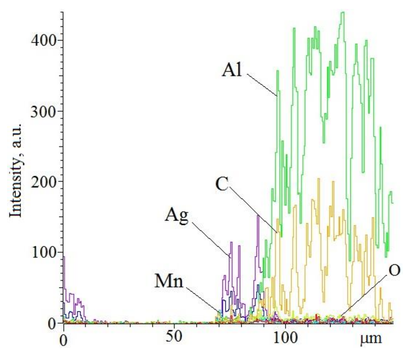
Microstructure of thick-film structures



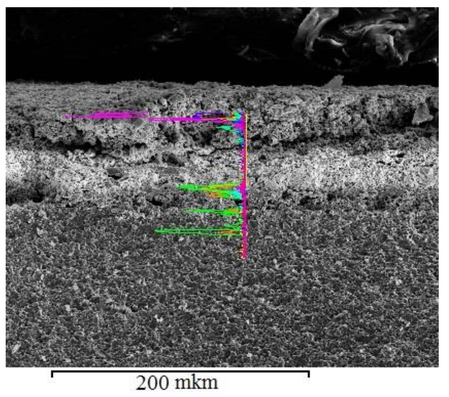


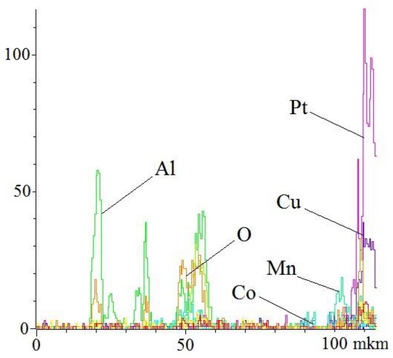
Microstructure and element composition of humidity-sensitive MgO-Al_2O_3 thick films formed as two-layered structure on Rubalit (Al_2O_3) substrate with formed conductive Ag layer





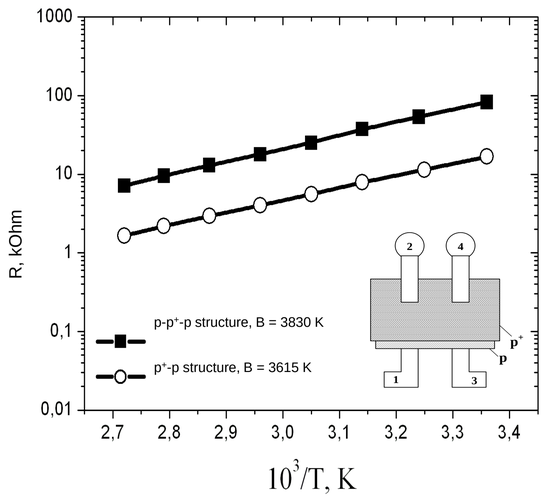
Microstructure and element composition of one-layered temperature-sensitive thick films formed as on Rubalit (Al_2O_3) substrate with formed conductive Ag layer

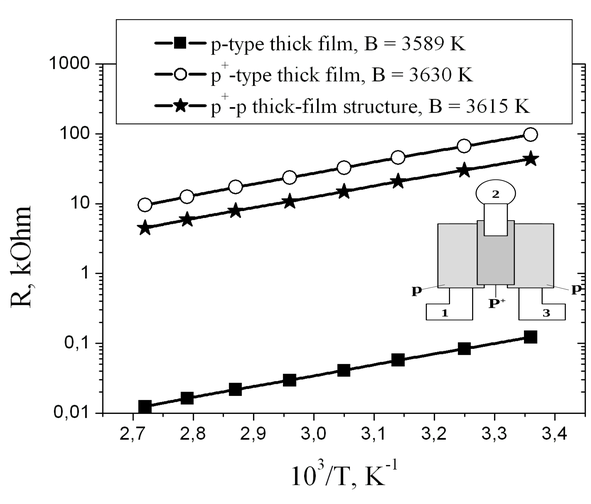


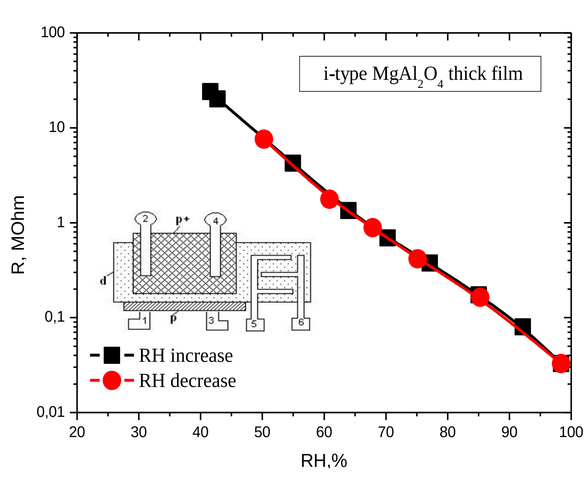


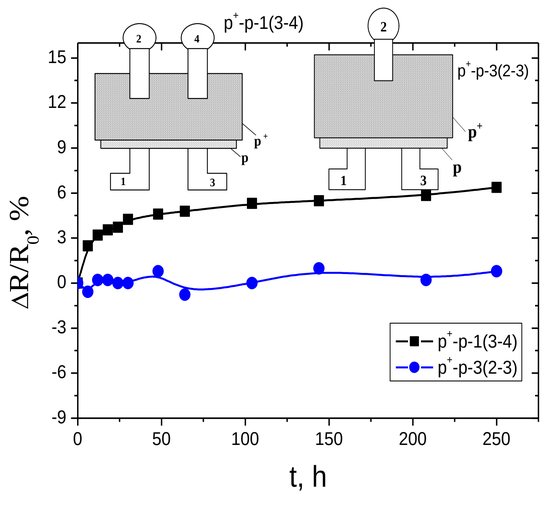
Microstructure and element composition of two-layered p^+-*i* structure formed on substrate with conductive layer

Exploitation properties









The temperature sensitive one-layered p^+, *p*-conductive thick films and double- *p*-p^+ and triple-layered *p*-p^+-*p* structures posses good linear electrophysical characteristics in the region from 298 to 358 K in semi-logarithmic scale. But the values of temperature constant B (temperature sensitivity of elements) increase from 3589-3595 K in p^+ and p thick films to 3615 K to 3830 K in double- *p*-p^+ and triple-layered *p*-p^+-*p* thick-film structures, respectively. The value of $\Delta R/R_o$ electrical drift does not exceed 1 %