Approaches to fabrication and characterizing of ceramic-based thick-film nanostructures for sensor applications

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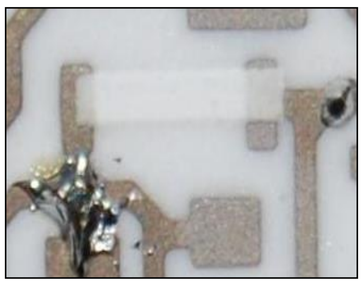
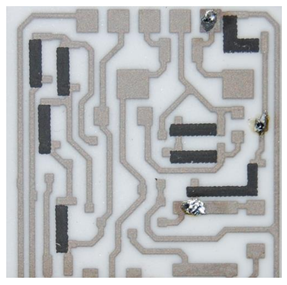
Phase composition and microstructural properties thick-film nanostructures based on humidity-sensitive $MgO-Al_2O_3$, temperature-sensitive $Cu_{0,1}Ni_{0,1}Co_{1,6}Mn_{1,2}O_4$ and $Cu_{0,1}Ni_{0,8}Co_{0,2}Mn_{1,9}O_4$ ceramics were investigated. Temperature-sensitive thick films contain three phase, while humidity-sensitive thick films are practically monophase. Pores in temperature-sensitive thick-film nanostructures are formed in clusters, while humidity-sensitive layers contain a significant amount of small pores, which serve as channels for the flow of water to nanopores.

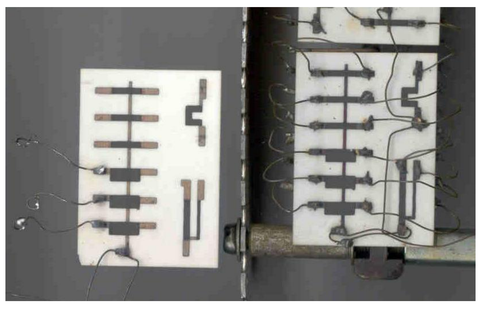
Active elements of temperature- and humidity-sensitive thick-film nanostructures

Humidity-sensitive i-type $MgO-Al_2O_3$

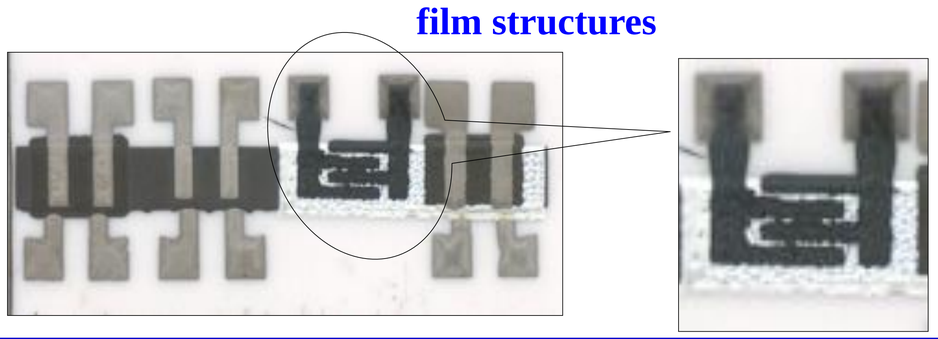


Temperature-sensitive $Cu_{0.1}Ni_{0.1}Co_{1.6}Mn_{1.2}O_4$

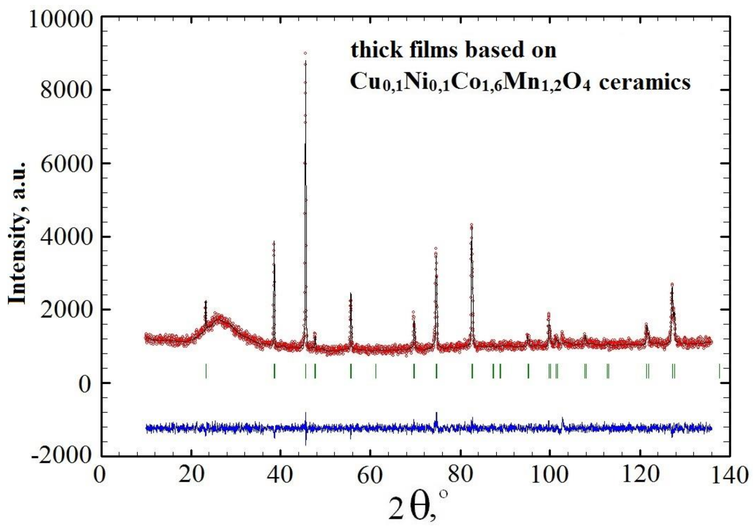




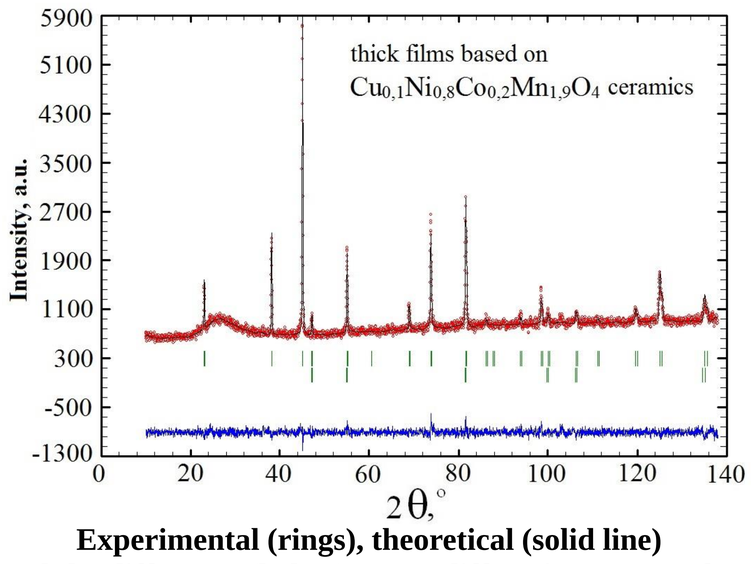
Integrated p-i-p+ temperature- and humidity-sensitive thick-film structures



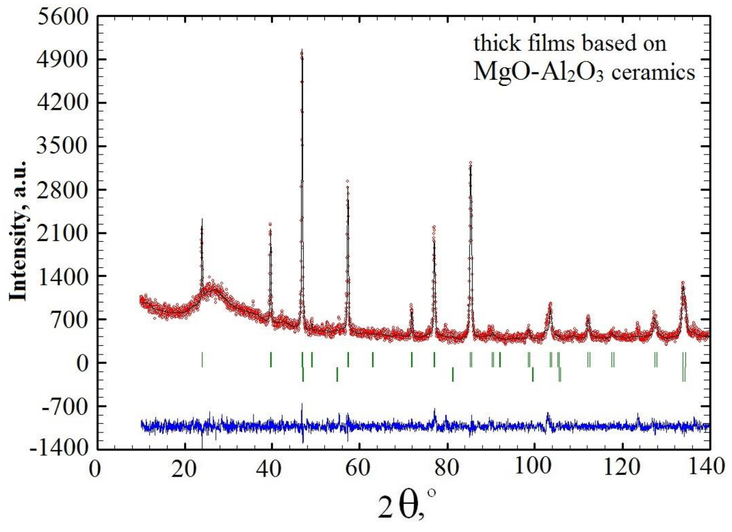
Phase compositions of thick-film structures



Experimental (rings), theoretical (solid line) and the difference (below) of X-ray diffraction patterns for $Cu_{0,1}Ni_{0,1}Co_{1,6}Mn_{1,2}O_4$ thick films

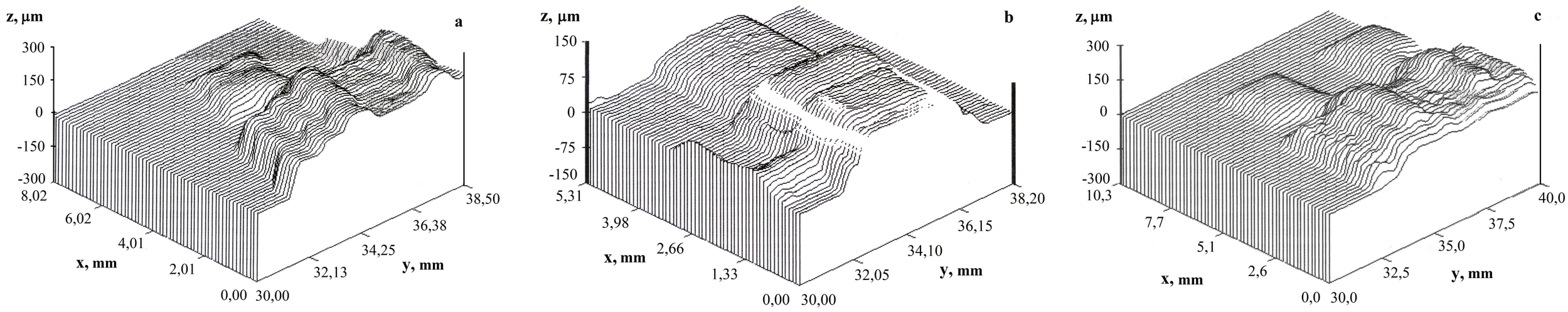


Experimental (rings), theoretical (solid line) and the difference (below) X-ray diffraction pattern for $Cu_{0,1}Ni_{0,8}Co_{0,2}Mn_{1,9}O_4$ thick film (the upper series of reflex marks is the spinel phase, the lower one is $(Ni_{1-x}Mn_x)O$)



Experimental (rings), theoretical (solid line) and the difference (below) X-ray diffraction pattern for $MgO-Al_2O_3$ thick films (the upper series of reflex marks is the spinel phase, the lower one is MgO)

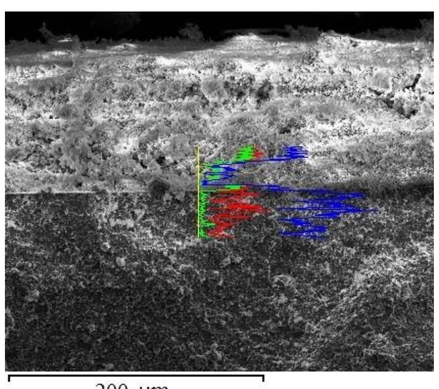
Topology of thick-film structures

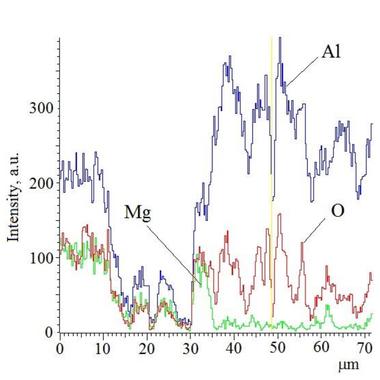


Topology of p-p^+ (a), p^+-i (b) and integrated p-i-p^+ (c) thick-film structures

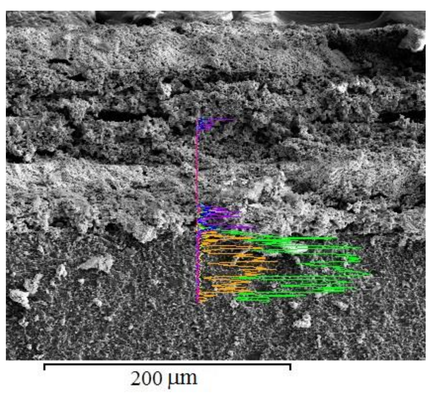
In accordance with results of topological investigations using 3D-profilograph Rodenstock RM600 (Germany), thickness of temperature-sensible p- and p+-layers was 43.75 μm and 46.88 μm, accordingly. The of two-layered p^+-i thick-film structure is 139.06 μm, p^+-p – 110.16 μm, and integrated p-i-p+ thick-film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

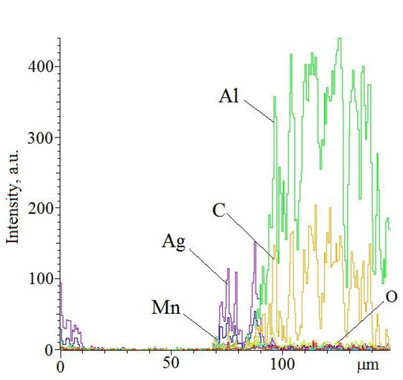
Microstructure of thick-film structures



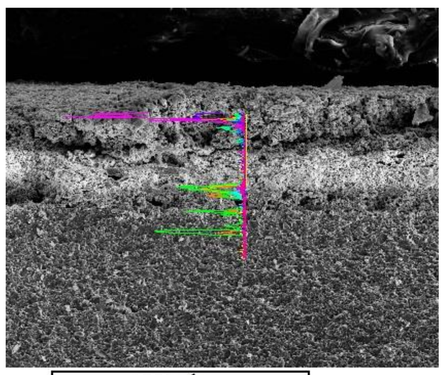


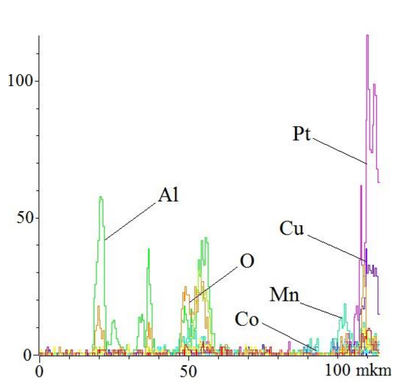
Microstructure and element composition of humidity-sensitive $MgO-Al_2O_3$ thick films formed as two-layered structure on Rubalit (Al_2O_3) substrate with formed conductive Ag layer





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