Nanocomposites and nanomaterials

Structural and magnetic properties of $Cu_xNi_{1-x-y}Co_{2y}Mn_{2-y}O_4$ ceramics with nanosized oxide second phases

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Manganite spinel ceramics, based on 3*d*-transition metals, are commonly used as a material for negative temperature coefficient thermistors. Owing to the formation of two or more sublattices in the spinel, the resulting magnetic moment, which is created by magnetic Ni, Co or Mn cations situated in different sublattices, can be uncompensated. As a result, such materials reveal ferrimagnetic behavior, being the prospective candidates for application in the field of spintronics.

Investigated $Cu_xNi_{1-x-y}Co_{2y}Mn_{2-y}O_4$ ceramics (compositions x=0.1, y=0.1; x = 0.8,y = 0.1 and x = 0.1, y =0.8) was fabricated by the conventional ceramic technology using a route of the carbonate preparation [1]. XRD spectrum revealed the only one cubic spinel phase (space group $Fd\bar{3}m$) for all synthesized samples, with lattice constants in the range of 0.829 – 0.839 nm, depending on the composition. However, morphological and compositional investigations by means of SEM patterning and EDX analysis clearly indicated the presence of additional nanosized particles of nickel and copper oxides on the grain boundaries of $Cu_{0.1}Ni_{0.8}Co_{0.2}Mn_{1.9}O_4$ and $Cu_{0.8}Ni_{0.1}Co_{0.2}Mn_{1.9}O_4$, respectively. Effective magnetic moments and Curie temperature of the compounds were determined by measuring the temperature dependences of their magnetic susceptibility. All specimens show transition from ferrimagnetic to paramagnetic state with the highest Curie temperature of 194 K for $Cu_{0.1}Ni_{0.1}Co_{1.6}Mn_{1.2}O_4$ composition. Magnetization curves of $Cu_{0.1}Ni_{0.8}Co_{0.2}Mn_{1.9}O_4$ and $Cu_{0.8}Ni_{0.1}Co_{0.2}Mn_{1.9}O_4$ in paramagnetic region form so-called “tails” of magnetization originated from inhomogeneity of the ferromagnetic species, which make ferrimagnetic-paramagnetic transition indistinct. Obviously, “magnetization tails” in Cu- and Ni-enriched samples is related with the presence of additional oxide phases on their grain boundaries.

1. *Shpotyuk O., Balitska V., Hadzaman I., Klym H.* Sintering-modified mixed Ni–Co–Cu oxymanganospinels for NTC electroceramics // J. Alloys Comp. – 2011. – **509**, P. 447–450.