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Electrophysical and magnetoresistive properties of high-entropy film alloys

I.Yu.Protsenko, L.V.Odnodvorets, S.I. Vorobiov, O.P.Tkach, Yu.M.Shabelnyk

Sumy State University, R.-Korsakov Str., 2, 40007 Sumy, Ukraine
E-mail: i.protsenko@aph.sumdu.edu.ua

Of great interest to high - entropy alloys (HEA), found of authors [1], as related to their unique mechanical properties and feature thermodynamic of equiatomous alloys with number of components to form more than five single-phase system, not multiphase, as required by thermodynamics. Only in case of deviation from equiatomous additional phases can be formed with redundant components. Purpose of the work was to study the characteristics of the phase composition, electrophysical and magnetoresistive properties of HEA, which were obtained by simultaneous condensation of Fe, Co, Ni, Cu and Cr (six or seven components were Al and Ti) or layers condensation of these metals, followed by annealing [2]. Because the study of films HEA is launched only unlike these alloys in bulk form, we should expect significant new results in respect of the implementation of size effects (factor of total thickness and individual layers thickness).

Investigation of the temperature dependence of the resistivity and thermal coefficient of resistance (TCR) fcc phase based on Cu Co, Cr, Fe, Ni and Al (a = 0,3604 nm) indicate a relatively high TCR value, which change on the range $(1{,}6 – 2{,}1)10^{-3}$ K^{-1}, with additional layers of Al and Ti does not significantly affect the TCR. At the same time, decrease the total thickness of the film in two times (from 60 to 28 nm) causes an increase in TCR of about 20%, can be explained by more efficient mixing of components at the stage of condensation and annealing. Magnetoresistive properties suggest implementing on anisotropic magnetoresistance (MR) with an amplitude of 0,06 to 0,21%. The feature of the MR is that when perpendicular to the substrate and the current orientation of the magnetic field (B) in unannealed samples in which ferromagnetic layers of Co and Fe are separated by a layer of antiferromagnetic Cr, depending of MR versus B have the same form as in the spin-valve structures but at the annealing to 800 K these dependencies are transformed into simple, but with a large hysteresis (the distance between the peaks on the curves of magnetization and demagnetization) 400 mT.

1. *Huang P.-K., Yeh J.-W., Shun T.-T., Chen S.-K.* // Adv.Eng.Mater. – 2004. – **6**. – P. 74–78.

2. *Vorobiov S.I., Kondrakhova D.M., Nepijko S.A., Poduremne D.V., Shumakova N.I., Protsenko I.Yu.*// J. Nano- Electron. Phys. – 2016. **8**, N 3.–P. 03026.