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The effect of annealing on the magnetoresistive properties of $(FeNi)_xCo_{1-x}$ thin films

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Thin films of soft magnetic alloys (FeNi or his alloys with addition of third elements) are widely used as sensing elements for magnetic field detection applications, for example, in magnetic recording read heads or low field measuring devices [1, 2].

Results of investigations magnetoresistive properties for two series of samples with different Co concentrations before and after annealing are presented in this work. A series of $(Fe_{20}Ni_{80})_xCo_{1-x}$ ($x \cong 55$ and 65 %, x is the vol. %) films were deposited in an oil vapor-free vacuum of $\sim 10^{-4}$ Pa by thermoresistive coevaporation technique using permalloy 79NM ($c_{Ni} \cong 80$ %) and Co independent sources. The films of total thickness 50-60 nm were deposited on the amorphous substrates heated to 480 K. After that samples were annealed at 700 and 900 K during 20 min. The magnetoresistance (MR) determined as $\Delta R/R_S = [(R(B) - R_S)/R_S]\cdot 100$ %, (where R_S is the film resistance in the saturation field (B_S) and $R(B)$ is the resistance in magnetic field B) was measured using 4-point technique in magnetic field (B) up to 500 mT at room temperatures. The magnetoresistive measurements were carried out at CIP geometry of current in two different geometries of applied field: perpendicular geometry (the applied field B perpendicular to the film plane) and transverse geometry (the applied field B in the film plane). All MR curves of unannealed samples show a similar shape to each other, has low values of MR (0,02-0,04 %) and coercivity ($B_C \cong 20$ mT for transverse geometry) and has not saturation field. The value of MR has increased after annealing to 700 and 900 K, B_C changed for perpendicular geometry and has values 95 mT, 40 mT ($c_{Co} \cong 55$ %) and 30 mT, 75 mT ($c_{Co} \cong 65$ %) respectively, but B_C stayed the same for transverse geometry of measurements.

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1. P. Ciureanu, *Thin-Film Resistive Sensors* (IOP: London: 1992).
2. C.S. Roumenin, *Solid State Magnetic Sensors* (Elsevier: Amsterdam: 1994).