

Influence of heat treatment on magnetic properties of Cu-Sn-Co-based materials produced by powder metallurgy

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In the foundation of this work is the issue for production of non-magnetic materials with predetermined weak magnetic properties. Preferable solution is to dope these materials with ferromagnetic impurities in low concentrations. One of the efficient ways to obtain such materials is the use of powder metallurgy which gives an opportunity to produce complex powder compositions with variety of components in precisely specified concentrations.

As an research object powder compositions of systems Cu-Sn (8 wt. % Sn) and Cu-Sn-P (8 wt. % Sn; 0,5 wt. % P) with the addition of 1,5 wt. % Co were chosen. After mixing and pressing all samples were heat treated at 800 °C with different cooling rates.

Noticeable solubility of components in Cu-Co system is observed at high temperatures [1]. This fact makes it possible to form specified magnetic properties only by formation of metastable solid solution with the further annealing in order to exclude Co particles from Cu (reduce Cu concentration in Co solid solution) and change the quantity of ferromagnetic domains in material [2]. Experimental results in this work with fast cooled Cu-Sn-Co system samples showed the same except there was no solubility of Co in Cu-Sn matrix. Anyway Co-Cu solid solution formation reduces sample magnetization in comparison with the pressed one. Formation of Cu-Sn-Co solid solution was discovered only after Cu₃Sn chemical compound started to grow due to lower cooling rates. In the second case saturation magnetization became lower than for fast cooled sample because diffusion of Co into Cu-Sn solid solution was appeared and consequently the amount of ferromagnetic Co decreased.

In the fast cooled samples of Cu-Sn-P-Co system besides the partially dissolution of Cu in Co diffusion of phosphorus in Cu-Sn matrix with further formation of Co₂P chemical compound was occurred. Presence of cobalt phosphide decreased magnetic properties drastically because of paramagnetism of Co₂P [3]. In slow cooled samples additional phase of eutectic copper phosphide Cu₃P was discovered and saturation magnetization rose. Investigation of samples with various cooling rates proved that with the formation of tin-rich phase caused the dissolution of Co₂P with simultaneous diffusion of phosphorus to the boundaries of Cu₃Sn phase and formation of Cu₃P.

References

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