Nanocomposites and nanomaterials

The stress effect on crystallization and magnetic properties in Co-rich microwires.

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Co-rich microwires (MW) have an extremely considerable place among the composite materials due to their unique combination of physical properties and small size. They become very promising for applications as sensors. The great internal stresses in MW are occurred during the fabrication due to difference in the thermal expansion coefficients of the metallic nucleus and glass insulation.

MW of nominal composition $Co_{67,7}Fe_{4,3}Cr_3B_{15}Si_{10}$ (metallic nucleus diameter is 14μm and coating thickness 12 μm) was obtained by the Tailor-Ulitovski technique. The X-ray diffraction patterns of initial MW are characterized only some broad diffusive halos, which indicate an amorphous state. The size of the coherently diffracting domains are 2 nm. This structure determined magnetic properties of MW (coercivity (H_c)~130 A / m, saturation magnetization 0.6 T).

It was found that crystallization of MW passes in two stages. On the first stage at the temperature 497 ° C (30 min) primary crystals of α-Co are formed in an amorphous matrix. The mean size of primary α-Co crystals derived from the Selikov-Scherer formula, was approx. 30 nm. The volume of the crystalline phases accounted for 14%. The coercivity of MW was ~530 A/m. At the second stage of transformations at the temperature 500 ° C (30 min) the decomposition of residual amorphous matrix and formation of multiphase structure: α-, β-, Co, Co_2Si, and metastable phase Co_3B occurred.

Glass coating accelerates crystallization process. Annealing of MW with glass insulation in the same temperature range led to the increasing the mean size of primary α-Co crystals and the crystallized volume fraction to 35 nm. and 20% respectively. The coercivity of MW increased up to 2450 A/m, that is 5 times higher than one without insulation. Such a difference in the values of H_c can be explained by the shift of beginning the crystallization towards lower temperature.