Magnetic properties of amorphous and multiphase microscale wires

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Microscale magnetic wires with cylindrical symmetry possess unique magnetic properties due to the manufacturing process [1]. Among the advantages, the microwires have tunable magnetic properties both through varying the initial technical parameters and through varying magnetoelastic and magnetostatic anisotropy after the production process. As a result, ferromagnetic microwires have applications in security control and coding systems, sensitive sensors of magnetic fields, mechanical stresses, temperatures, deformation, as well as in microelectronics and medical applications [2, 3]. The applications mostly based on materials with an amorphous structure. These materials are difficult to be studied with X-ray techniques. At the same time, it has been shown recently that presence of several magnetic phases also has a potential application interest [4, 5]. The understanding of magnetic interactions in the amorphous and multiphase magnetic wires will help to increase efficiency of related devices based on such samples. In this work, a fundamental question on magnetic interactions in the amorphous and multiphase microwire is considered.

The Fe-, FeCo- and Co-based microwires were studied. The structural properties were investigated by the XRD and HRTEM. The phase transformations were studied and analyzed by DSC. Two stages of the crystallization processes were detected for as-cast amorphous microwire and the three-step crystallization processes were detected for the wire with a partially crystalline structure in the as-cast state. Presence of different components in metallic nucleus poses the presence of different magnetic phases. The FORC-analysis (First Order Reversal Curve) was applied to detect the interaction between different magnetic phases and to trace its influence on the magnetization reversal process. This offered an opportunity to discuss the relationship between magnetoelastic and magnetostatic interactions, micromagnetic structure formation. For partially crystalline wires a positive magnetic interaction was detected due to the magnetostatic interaction between the clusters of crystallites. More complex interaction in systems appears with presence in structure additional clusters of crystalline inclusions which provides interesting multiphase behavior.

References

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