Igor V Shchetinin et al., Res. Rev. J Mat. Sci. 2018, Volume 6
DOI: 10.4172/2321-6212-C6-030

Influence of production methods on structure and magnetic properties of $NdFe_{11}Ti$ based alloys and their nitrides

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Compounds based on Fe and rare earth elements with the structural type $ThMn_{12}$ have been known for more than 30 years and have fundamental magnetic properties comparable to the compound $Nd_2Fe_{14}B$. Nitrides of $NdFe_{12}$ compound have higher properties than those of $Nd_2Fe_{14}B$ compound: saturation magnetization 1.66 T, Curie temperature 550°C and anisotropy field 6.4 MA/m. However binary compounds RFe_{12} (R is rare-earth element) are stable only in the thin films forms. To stabilize this phases with $ThMn_{12}$ structural type transition metals that replace Fe are used $RFe_{12-x}M_x$ (where M = Al, Cr, V, Ti, Mo, W, Si or Nb) At present time these alloys have no practical application due to small values of hysteresis properties compared to the Nd-Fe-B system. In this regard, investigation of structure formation and magnetic properties of $NdFe_{11}Ti$ alloys quenched from the liquid state and subjected to heat treatment is an urgent task. As a result of these studies, methods and regimes for producing of $NdFe_{11}Ti$-$NdFe_{11}TiN$ compounds have been tested: melting, homogenizing annealing, quenching from a liquid state, and nitriding. It is shown that homogenizing annealing at a temperature of 1100°C for 168 h makes it possible to obtain a ferromagnetic phase with a structural type of $ThMn_{12}$. An almost single-phase state (97%) was produced by quenching from the liquid state without using prolonged annealing which increases the grain size of the $NdFe_{11}Ti$ phase to about 150 nm. It is shown that nitriding of the alloy leads to an increase in main magnetic hysteresis properties. The maximum magnetic hysteresis properties were obtained using a combination of quenching methods from the liquid state and nitriding: Hc = 1053 Oe, σr = 46 emu/g, σs = 139 emu/g.

Figure1: The results of transmission electron microscopy of samples after quenching from the liquid state.

Recent Publications

1. Glezer A M, Timshin I A, Shchetinin I V et al. (2018) Unusual behavior of long-range order parameter in Fe_3Al superstructure under severe plastic deformation in Bridgman anvils. Journal of Alloys and Compounds DOI: 10.1016/j.jallcom.2018.02.124.
2. Romankov S, Park Y C and Shchetinin I V (2018) Structural transformations in (CoFeNi)/Ti nanocomposite systems during prolonged heating. Journal of Alloys and Compounds 745:44-54.
3. Savchenko A G, Medvedeva T M, Shchetinin I V et al. (2017) Phase-structural state diagrams and hysteresis properties of rapidly solidified alloy $Nd_{10.4}Zr_{4.0}Fe_{75.1}Co_{4.1}B_{6.4}$ after heat treatment. Journal of Alloys and Compounds DOI: 10.1016/j.jallcom.2017.01.002.
4. Menushenkov A P, Ivanov V G, Shchetinin I V et al. (2017) XMCD study of the local magnetic and structural properties of microcrystalline NdFeB-based alloys. JETP Letters 105(1):38-42.

Biography

Igor V Shchetinin has completed his PhD in the year 2012 from National University of Science and Technology. He is the head of X-ray structure analysis and diagnostic of materials laboratory. He has published more than 60 papers in reputed journals and has been serving as an Editorial Board Member of repute.

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