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$_2$Fe$_{14}$B. Nitrides of NdFe$_{12}$ compound have higher properties than those of Nd$_2$Fe$_{14}$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: $H_c = 1053$ Oe, $\sigma_r = 46$ emu/g, $\sigma_s = 139$ emu/g.

Figure 1: The results of transmission electron microscopy of samples after quenching from the liquid state.

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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.