The microstructure, high performance magnetic hardness and magnetic after-effect of an α- FeCo/Pr$_2$Fe$_{14}$B nanocomposite magnet with low Pr concentration

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Abstract: In this paper, a systematic investigation of the microstructure, high performance magnetic hardness as well as novel magnetic memory effect of the Pr$_4$Fe$_{76}$Co$_{10}$B$_6$Nb$_3$Cu$_1$ nanocomposite magnet fabricated by conventional melt-spinning followed by annealing at temperatures ranging from 600 to 700 °C in Ar gas for nanocrystallization are presented and discussed. Transmission electron microscopy (TEM) observation confirms an ultrafine structure of bcc-Fe(Co) as a magnetically soft phase and Pr$_2$Fe$_{14}$B as a hard magnetic phase with a spring-exchange coupling in order to form the nanocomposite state. Electron diffraction analysis also indicates that the Co atoms together with Fe atoms form the Fe$_{70}$Co$_{30}$ phase with a very high magnetic moment (2.5μ$_B$), leading to a high saturation magnetization of the system. High magnetic hardness is obtained in the optimally heat-treated specimen with coercivity $H_c = 3.8$kOe, remanence $B_r = 12.0$kG, $M_r/M_s = 0.81$ and maximum energy product $(BH)_{max} = 17.8$MGOe, which is about a 25% improvement in comparison with recent results for similar compositions. High remanence and reduced remanence are the key factors in obtaining the high performance with low rare-earth concentration (only 4at.%). High-resolution TEM analysis shows that there is a small amount of residual amorphous phase in the grain boundary, which plays a role of interphase to improve the exchange coupling. Otherwise, in terms of magnetic after-effect measurement, a magnetic memory effect was observed for the first time in an exchange-coupled hard magnet. © 2009 IOP Publishing Ltd.

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