The microstructure, high performance magnetic hardness and magnetic after-effect of an ?- FeCo/$Pr_2Fe_{14}B$ 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 $Pr_4Fe_{76}Co_{10}B_6Nb_3Cu_1$ 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 $Pr_2Fe_{14}B$ 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 (2.5?$_B$), leading to a high saturation magnetization of the system. High magnetic hardness is obtained in the optimally heat-treated specimen with coercivity H_c = 3.8kOe, remanence B_r = 12.0kG, M_r/M_s = 0.81 and maximum energy product $(BH)_{max}$ = 17.8MGOe, 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.

Index Keywords: Coercivity; Electron diffraction analysis; Energy products; Fe atoms; Hard magnetic phase; Hard magnets; Heat-treated specimens; High-resolution TEM analysis; High-saturation magnetizations; Key factors; Magnetic after effects; Magnetic hardness; Magnetic memories; Melt-spinning; Nanocomposite magnets; Rare-earth; Residual amorphous phase; Systematic investigations; Tem; Ultra fine structures; Atoms; Exchange coupling; Grain boundaries; Hardness; Iron compounds; Magnetic moments; Magnetic storage; Magnets; Microstructure; Nanocomposites; Nanocrystallization; Niobium; Rare earth elements; Remanence; Saturation magnetization; Sodium compounds; Transmission electron microscopy; Magnetic materials; boron; cobalt; copper; iron; nanocomposite; nanocrystal; nanomaterial; nanoparticle; nanoribbon; niobium; praseodymium; article; concentration process; electron diffraction; energy; hardness; magnet; magnetic field; magnetism; nanochemistry; nanofabrication; particle size; priority journal; temperature; transmission electron microscopy

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