The effect of annealing temperature on the magnetic properties of Pr-(Fe,Co)-(Zr,Nb)-B ribbons

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The properties of the rapidly solidified ribbons of $Pr_9Fe_{50+x}Co_{13}Zr_1Nb_4B_{23-x}$ (where x = 0, 2, 5, 8) alloys annealed at temperatures ranging from 923 K to 1033 K were investigated. The heat treatment of the fully amorphous as-cast ribbons led to the simultaneous crystallization of the hard magnetic $Pr_2(Fe,Co)_{14}B$, the soft magnetic α-Fe and the paramagnetic $Pr_{1+x}Fe_4B_4$ phases. However, the crystallization of the α-Fe phase took place as the second crystallization event at higher temperatures for x = 0 and 8 alloys. Using Rietveld refinement of the X-ray diffraction patterns, the crystallite sizes of constituent phases were calculated. Additionally, using the PONKCS method the weight fractions of the crystalline and amorphous components were quantified. For all alloy compositions the temperature dependencies of magnetic parameters were determined from the hysteresis loops. The measurement of recoil curves allowed to determine the switching field distributions. Furthermore, the intergrain exchange interactions were analyzed based on δM plots.