Abstract

We report on how the microstructure and the silicon content of nanocrystalline ternary $(Fe_{0.8}Al_{0.2})_{100-x}Si_x$ powders (x=0, 5, 10, 15 and 20 at%) elaborated by high energy ball milling affect the magnetic properties of these alloys. The formation of a single-phase alloy with body centred cubic (bcc) crystal structure is completed after 72 h of milling time for all the compositions. This bcc phase is in fact a disordered Fe(Al,Si) solid solution with a lattice parameter that reduces its value almost linearly as the Si content is increased, from about 2.9 Å in the binary $Fe_{80}Al_{20}$ alloy to 2.85 Å in the powder with x=20. The average nanocrystalline grain size also decreases linearly down to 10 nm for x=20, being roughly half of the value for the binary alloy, while the microstrain is somewhat enlarged. Mössbauer spectra show a sextet thus suggesting that the disordered Fe(Al,Si) solid solution is ferromagnetic at room temperature. However, the average hyperfine field diminishes from 27 T (x=0) to 16 T (x=20), and a paramagnetic doublet is observed for the powders with higher Si content. These results together with the evolution of both the saturation magnetization and the coercive field are discussed in terms of intrinsic and extrinsic properties