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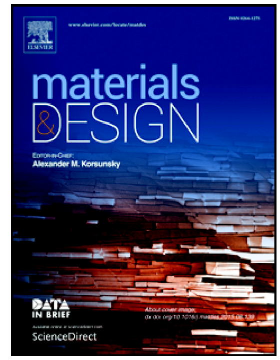

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Easy batch-scale production of cobalt ferrite nanopowders by two-step milling: structural and magnetic characterization

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Abstract

Cobalt ferrite (CF) powder was synthetized by solid state reaction method at two different calcination temperatures (1120 K and 1320 K) then milled in two steps, gradually reducing the milling media size. The first milling step results in CF nanoparticles with crystallite size of 33 nm showing fairly high coercivity (3.7 kOe), more than 5 times higher than the non-milled material (0.7 kOe). The high coercivity has been correlated was correlated to the crystallite size close to the single-domain limit, and to the strain increase up to 2.1%. This value of strain is the highest ever reported in literature for the CF and brings to the highest figure of merit for permanent magnets, $(BH)_{max}$ = 2.16 MGOe. After the second milling step the powder displays particle size of 9 nm, release of strain (ε = 1.2%), corecivity reduction that approaches 250 Oe and decrease of the deblocking temperature from 421 K to 317 K. The large tunability obtained by multi-step milling allows to use CF in different applications. In particular, the milled CF powder characterized by high microstrain is a good candidate for the realization of rare-earth-free permanent magnets (at least on the basis of the $(BH)_{max}$ product). For the first time, a correlation between the spin-canting angle and the degree of inversion, the crystallite size and the microstrain is presented and discussed.