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Ultrafine nanocrystalline NdFeB prepared by cryomilling with HDDR process

Fei Zhang[1], Ying Liu[1,2], Jun Li[1]*, Renquan Wang

[1] College of Material Science and Engineering, Sichuan University, Chengdu 610065, The People's Republic of China

[2] Key Laboratory of Advanced Special Materials & Technology, Ministry of Education, Chengdu 610065, The People's Republic of China

Corresponding author: Jun Li

E-mail: abthonyli@163.com

Tel: +86-028-85405332

Abstract: In this work, the NdFeB ribbons ($Nd_{13.5}Fe_{73}Co_{7.5}B_6$) were first subjected to the hydrogenation disproportionation (HD) to prepare disproportionation Nd-Fe-B precursor and subsequently cryomilled for different times. The submicron NdFeB particles with ultrafine nanocrystalline were finally obtained after desorption recombination (DR) process. The results indicated that with the increase of the cryomilling time, $Nd_2Fe_{14}B$ grains were refined to nanoscale, but the coercivity decreased due to the strong exchange coupling between the nano-grains. The optimized nanocrystalline NdFeB particles have a size of 40 nm or less and present a coercivity of 6.63 kOe after cryomilling for 10 hours followed by DR treatment at 800°C for 10 min. To further improve the magnetic properties, Ca was added into HD powders in the course of cryomilling process to protect the powders from oxidation and a noticeable coercivity of 9.49 kOe was obtained. Finally, the mechanism of magnetic interactions and coercivity enhancement were discussed.