High-gas pressure stabilization of the meta-stable magnetic hydrides, oxides, and nitrides

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A number of ferromagnetic materials, including La-Fe-Si-H, Sm-Fe-N, CrO_2, α″-$Fe_{16}N_2$, etc., are unstable at elevated temperatures, and this has become bottleneck for the synthesis and applications of these materials. In this work, a high-gas pressure heat-treatment device designed by Si was employed to suppress the decomposition of La-Fe-Si-H, Sm-Fe-N, and CrO_2. The self-made device can work under $H_2/O_2/N_2$ gas pressures up to 100 MPa and in temperatures up to 1000 ℃. [1] High-density $La_{0.5}Pr_{0.5}Fe_{11.4}Si_{1.6}$ hydride sintered plate with a large magnetic-entropy change that almost twice as large as that of bonded $La(Fe,Si)_{13}$ hydrides were obtained under 50 MPa H_2 heat-treatment.[2] The high pressure H_2 suppresses desorption of H atoms and thus makes high temperature sintering possible. This work opens an effective route for synthesizing thin magnetic refrigerants of $La(Fe, Si)_{13}H_x$ hydrides. [3] High-performance $Sm_2Fe_{17}N_x$ powders were obtained by nitriding Sm_2Fe_{17} under N_2 with gas pressures up to 40 MPa, which is beneficial in suppressing the decomposition of $Sm_2Fe_{17}N_x$ and enhancing the nitrogen absorption rate, and thus is effective for synthesizing high-quality Sm-Fe-N.[4] The Mn_4N prepared under high N_2 gas pressures exhibits much larger coercivity in comparison with that prepared under ambient N_2 pressures.[5] Ultra-high purity CrO_2 were prepared by decomposing CrO_3 under 40 MPa O_2. [6] The CrO_2 nano- and micro-particles were prepared by nitriding Cr_2O_3 under high O_2 pressures. [7, 8] The influence of high-pressure nitrogenation on the structure and magnetic properties of $SmFe_{10}Mo_2$ and $La_{0.5}Pr_{0.5}Fe_{11.4}Si_{1.6}$ has also been studied. [9, 10] High gas pressure heat-treatment can to some extent enhance the gas-solid reaction rate, enriching the gas-atom concentration in the final products, and suppress the decomposition of meta-stable compounds.

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