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, CrO2, α″-Fe16N2, etc., are unstable at elevated temperatures, and this has become a 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 CrO2. The self-made device can work under H2/O2/N2 gas pressures up to 100 MPa and in temperatures up to 1000 °C. [1] High-density La0.5Pr0.5Fe11.4Si1.6 hydrides 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 H2 heat-treatment.[2] The high pressure H2 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)13Hx hydrides. [3] High-performance Sm2Fe17:Nx powders were obtained by nitriding Sm2Fe17 under N2 with gas pressures up to 40 MPa, which is beneficial in suppressing the decomposition of Sm2Fe17:Nx and enhancing the nitrogen absorption rate, and thus is effective for synthesizing high-quality Sm-Fe-N.[4] The Mn4N prepared under high N2 gas pressures exhibits much larger coercivity in comparison with that prepared under ambient N2 pressures.[5] Ultra-high purity CrO2 were prepared by decomposing CrO3 under 40 MPa O2. [6] The CrO2 nano- and micro-particles were prepared by nitriding Cr2O3 under high O2 pressures. [7, 8] The influence of high-pressure nitrogenation on the structure and magnetic properties of SmFe2Mo2 and La0.5Pr0.5Fe11.4Si1.6 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.

References

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