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Properties of SPS-processed permanent magnets prepared from gas-atomized Nd-Fe-B powders

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Abstract:

Different grades of Nd-Fe-B permanent magnets are available on the market today and their magnetic properties highly depend on the microstructure, which is controlled by the chemical composition of the alloy and the magnets' manufacturing route. Gas atomization is a rapid solidification technique that is seldom used for the production of Nd-Fe-B magnetic powders due to the cooling rates that are several orders of magnitude lower than those achieved with the melt spinning. In addition, rare-earth-rich powders experience significant loss of hard magnetic properties at high temperatures in air. We prepared a novel type of bulk Nd-Fe-B permanent magnet from gas-atomized powders using the Spark Plasma Sintering (SPS) technique. Samples manufactured from rare-earth-poor material were porous, while high density was achieved with a neodymium-rich powder. The high-temperature instability was effectively overcome with compaction of the atomized material into a dense magnet. The intrinsic coercivity of the latter surpassed the value of the optimally heat-treated spherical powder. The samples' magnetic, as well as the mechanical properties, reflected the unfavourable microstructural characteristics of the initial atomized material. Refinement of the microstructure achieved with sieving increased the coercivity of the heavy-rare-earth-free bulk magnet to ~ 1000 kA/m.

Keywords:

Permanent magnets, rapid-solidification, sintering, mechanical properties, magnetic measurements, microstructure

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