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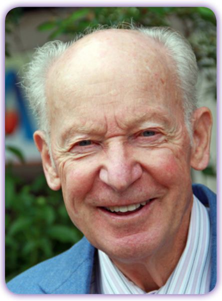

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Dy-free high strength, high coercivity $Nd_2Fe_{14}B$ based-permanent magnets

Nd2Fe14B based permanent magnets are the current state of the art for high performance magnets. However, for high temperature (>475K) operation, electric drive motors and wind turbines require the addition of significant quantities of Co and Dy (an energy critical element). By substitution of Ce, the most abundant rare earth element, for Nd (an energy critical element in tight supply) and Co for Fe the temperature dependent magnetic properties of Nd2Fe14B were significantly improved without Dy. Rapidly solidified $(Nd_{0.8}Ce_{0.2})2.4(Fe_{12}Co_2)B$ alloy ribbons have an energy product (the strength of a magnet) BHmax = 12.2 MGOe (~12% less than Nd2Fe14B) and a coercivity (the ability to resist demagnetization by an applied field) Hci = 15.4 kOe (1.8 times larger). We believed that selective site occupancy of mixed-valent $Ce^{3.2+}$ for Nd results in an associated selective site occupation by Co in Fe sites thereby mitigating any detrimental effects of Co may have on the coercivity. This synergistic interaction between Co and $Ce^{3.2+,}$ when combined with the fine microstructure of rapidly solidified ribbons, resulted in an Hci of the Ce, Co-doped NdFeB alloy that exceeded Hci of a sintered Dy-doped NdFeB permanent magnet at 483 K. Based on this chemistry, anisotropic MQ3 magnets, which were prepared by hot pressing and die upsetting, exhibited an Hci of 9.5 kOe and BHmax of 32.4 MGOe. The Ce, Co doped die upset NdFeB magnets have the potential to replace many Dy containing sintered alloys, and thus reduce USA's dependence on China for Dy and Nd.

Biography

Karl A Gschneidner, Jr. is an Anson Marston Distinguished Professor, Department of Materials Science and Engineering, Iowa State University; a Senior Metallurgist and the Chief Scientist of the Critical Materials Institute, Ames Laboratory. Gschneidner is considered the world's foremost authority of rare earth science and technology: ran the Rare-earth Information Center (30 years), published over 511 papers, holds 15 patents, and given 328 invited presentations, senior editor (40+ volumes) Handbook on the Physics and Chemistry of Rare Earths (34 years). He is a member of the National Academy of Engineering, and received over 25 awards, including Fellowships in 5 professional societies.

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