



Development of Improved Powder for Bonded Permanent Magnets



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Alloy Design

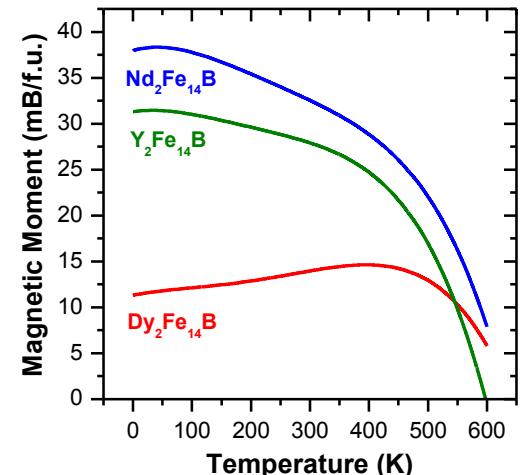
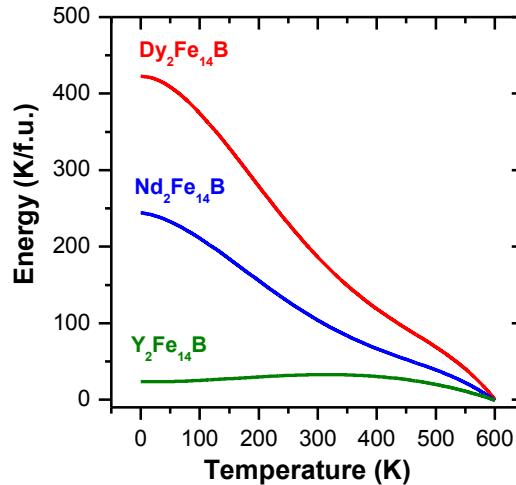


➤ Why YDy-based $R_2Fe_{14}B$?

Intrinsic magnetic properties
of $R_2Fe_{14}B$ compounds

	M_s (kGs)	H_a (kOe)
$Nd_2Fe_{14}B$	16	73
$Y_2Fe_{14}B$	14.1	26
$Dy_2Fe_{14}B$	7.1	~150

Temperature dependence of anisotropic energy
and magnetic moment of $R_2Fe_{14}B$ compounds



(After R. Grössinger [2], S. Hirosawa [3], E. B. Boltich [4], D. Givord [5])

- The H_a of $Y_2Fe_{14}B$ and the M_s of $Dy_2Fe_{14}B$ exhibit a weak temperature dependence which initially rises above room temperature before decreasing as the Curie temperature T_c is approached.

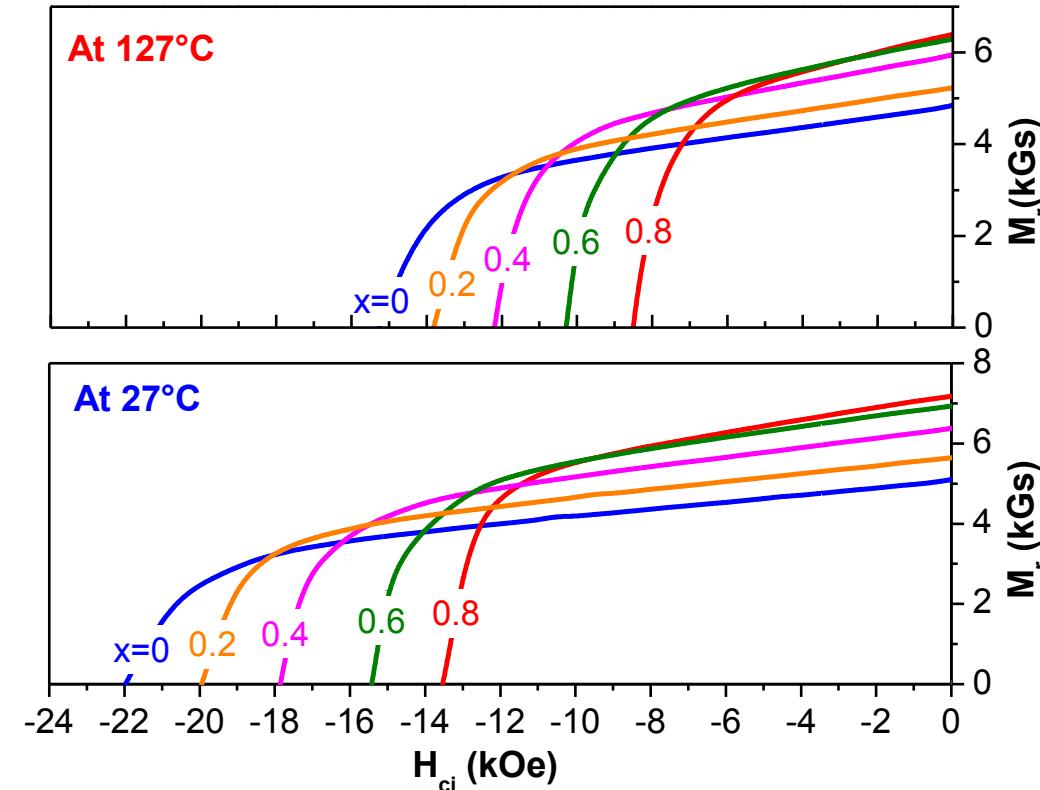


Effect of Nd-Substitution



Demagnetization Curves

Annealed $[Nd_x(YDy)_{0.5(1-x)}]_{2.2}Fe_{14}B$ ribbons with different Nd contents



- With increasing Nd content, the remanence increases, while coercivity decreases.
- The demagnetization curves exhibit good squareness at both 27 and 127°C.



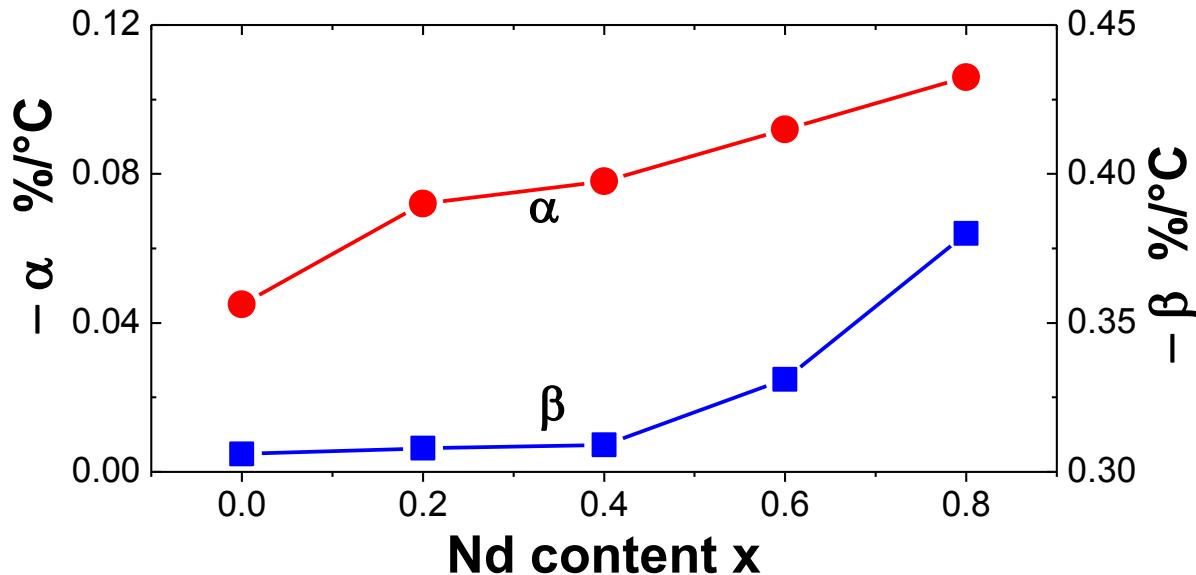
FreedomCAR

Effect of Nd-Substitution



Thermal Stability From 27 to 127°C

Annealed $[Nd_x(YDy)_{0.5(1-x)}]_{2.2}Fe_{14}B$ ribbons with different Nd contents



- α monotonically increases from -0.045 to -0.106 %/°C with increasing x from 0 to 0.8, while β has an essentially constant value of -0.3 %/°C when x is below 0.4.
- The thermal magnetic properties in a wide range of Nd substitution are much better than those of Nd-based ribbons.

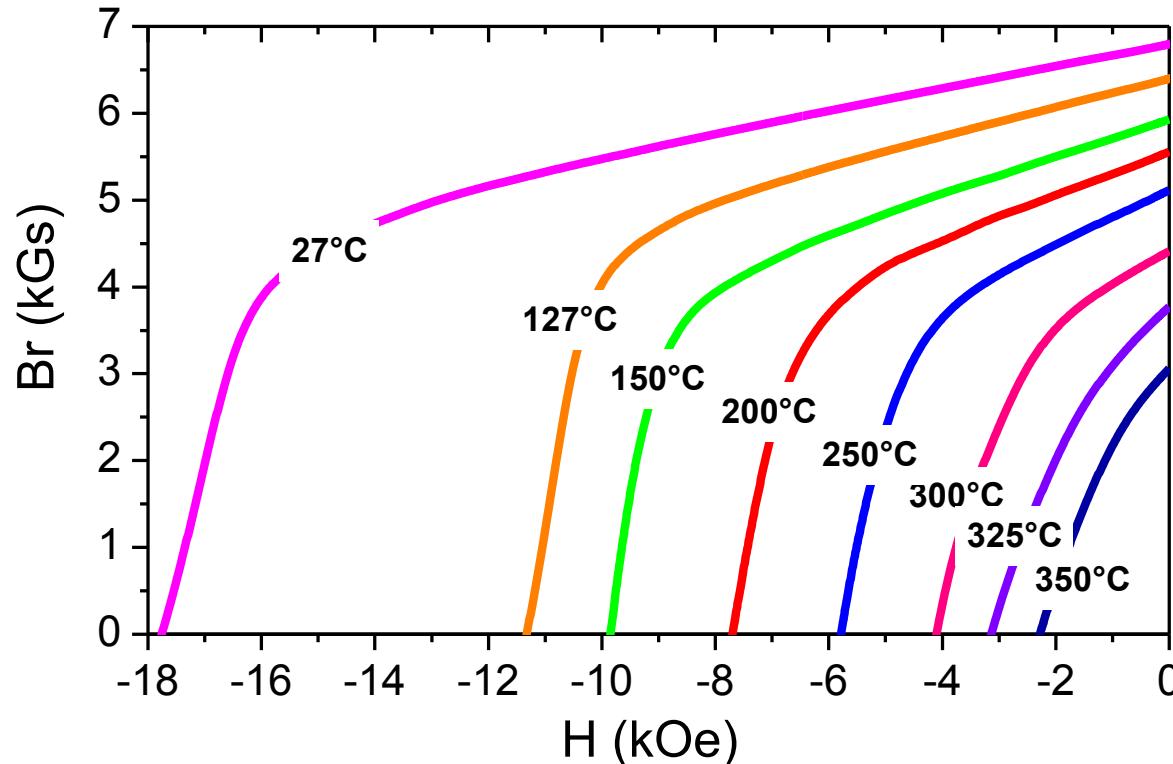


Effect of Co-Substitution



Demagnetized Curves

Annealed $[Nd_x(YDy)_{0.5(1-x)}]_{2.2}Co_{1.5}Fe_{12.5}B$ ribbons annealed at 750°C for 15 min.



- The demagnetization curves exhibit good squareness at high temperature, even at 300°C.



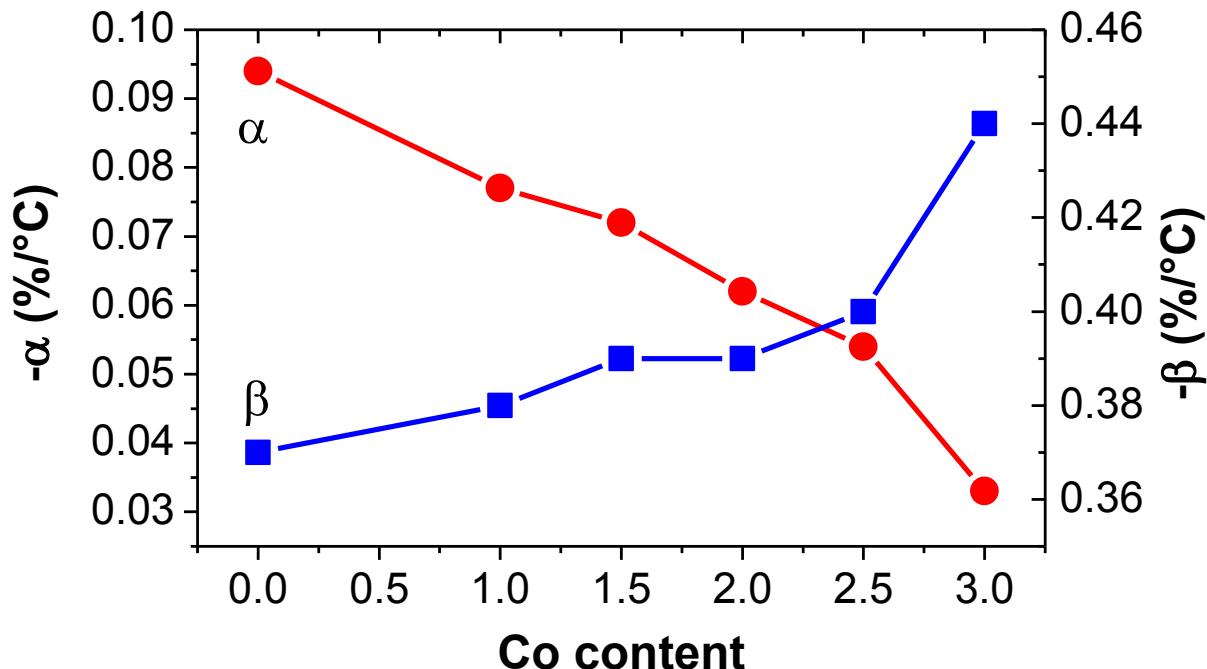
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Effect of Co-Substitution



α and β as a Function of Co Content

Annealed $[Nd_{0.5}(YDy)_{0.25}]_{2.2}Co_yFe_{14-y}B$ ribbons annealed at 750°C for 15 min.



- With increasing Co content, α decreases, while β increases.



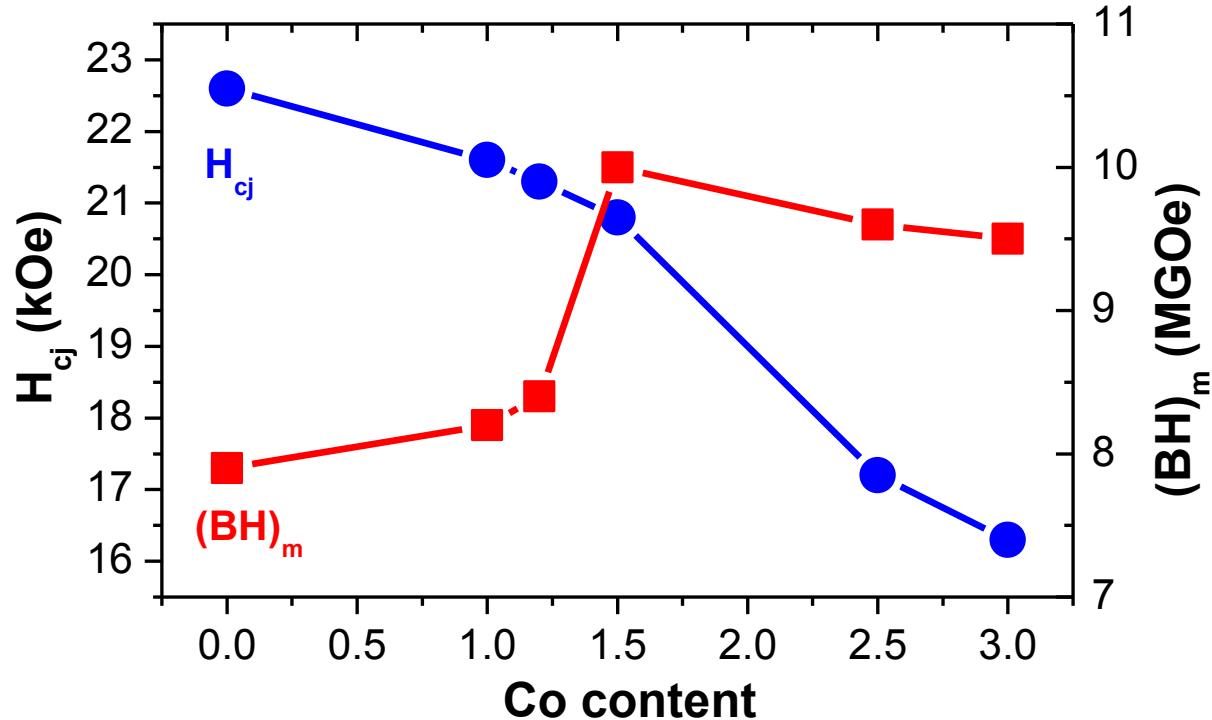
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Effect of Co-Substitution



H_{cj} and $(BH)_m$ as a Function of Co Content

Annealed $[Nd_x(YDy)_{0.5(1-x)}]_{2.2-y}Co_yFe_{12.5}B$ ribbons annealed at 750°C for 15 min.



- With increasing Co content, H_{cj} slightly decreases. $(BH)_m$ firstly increases and reaches its maximum value, and then slowly decreases.



Alloy SUMMARY



- ❑ YDy-based $[Nd_x(YDy)_{0.5(1-x)}]_{2.2}Fe_{14-y}Co_yB$
- ❑ compensate the loss of M_s and H_{cj} due to heating
- ❑ simultaneously yield smaller temperature coefficient of B_r and H_{cj} .
- ❑ The desired properties and thermal stability can be optimized by a judicious mixture of Nd-Y-Dy.
- ❑ The YDy-based $R_2Fe_{14}B$ magnets are very promising for high temperature performance.



WT-096 Ames Alloy Composition Converted into 100 kg of Particulate (MQP-11HTP) by Magnequench International

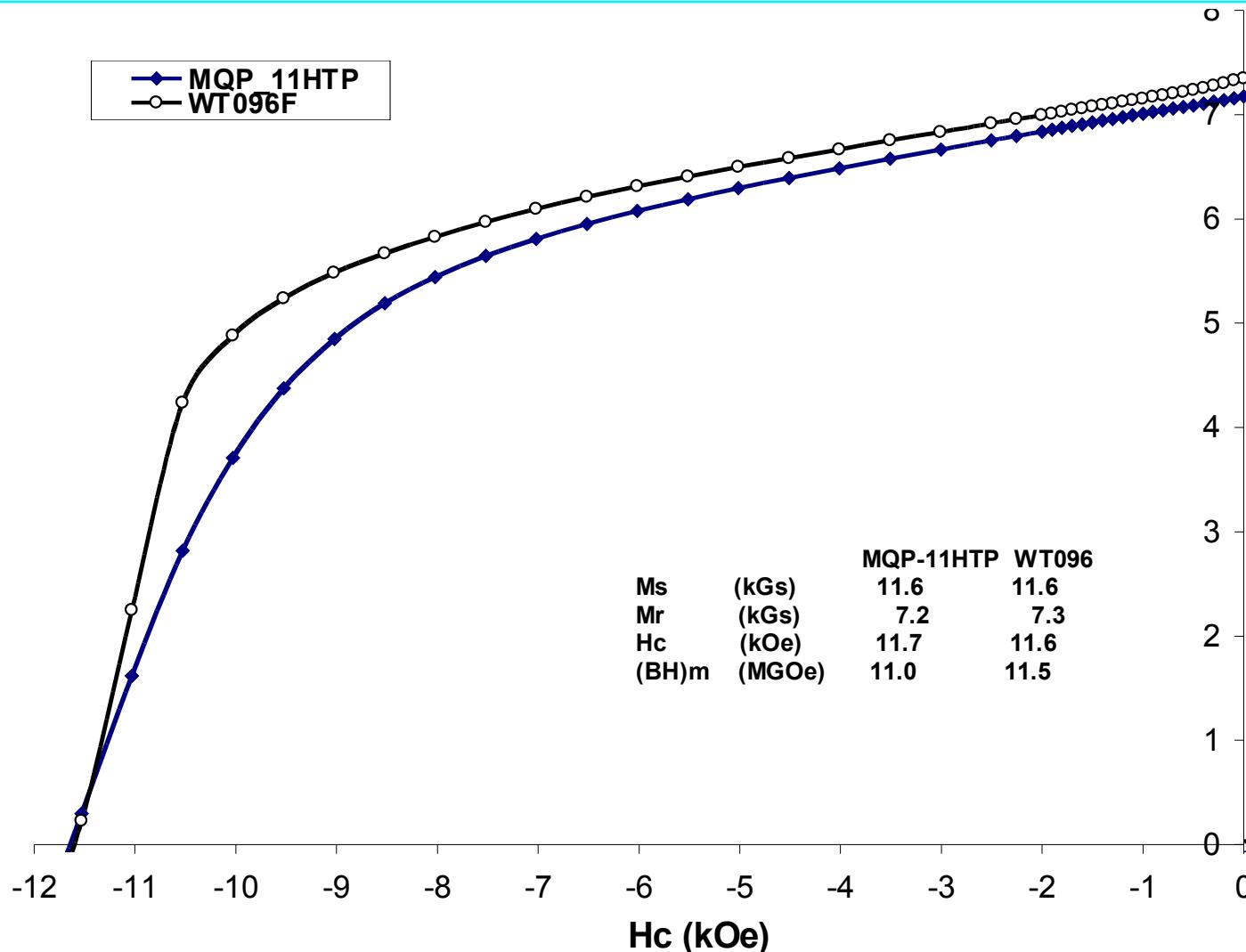


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Comparison of Composition and Magnetization of WT-096 and MQP-11HTP





Estimated alloy performance

