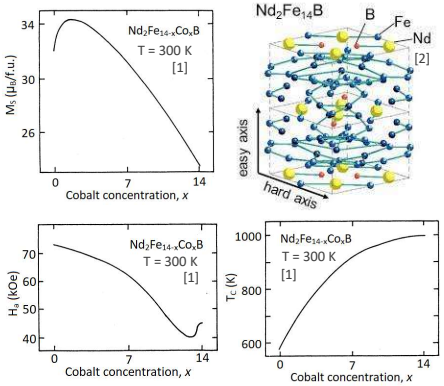
Magnetic properties of Lu and Y doped Ce-Fe-B magnets

Alex Bretaña, Binod Rai, Catherine Housley, Henry Ajo, Gregory Morrison, Hans-Conrad zur Loye

Introduction

The growing **demand for $Nd_2Fe_{14}B$ magnets is exacerbating the current critical materials shortage**. To reduce the amount of critical material in $Nd_2Fe_{14}B$ magnets, **chemical substitutions have been used and shown to improve the magnetic behavior**, such as the Curie Temperature T_C, anisotropy field H_a, and saturation magnetization M_S.



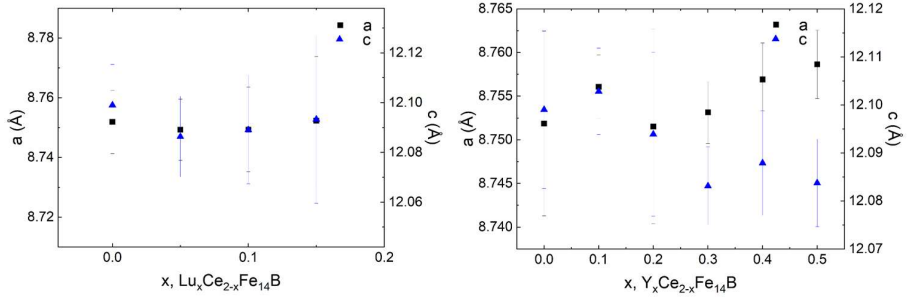
Critical Material Free – Permanent Magnet: $Ce_2Fe_{14}B$

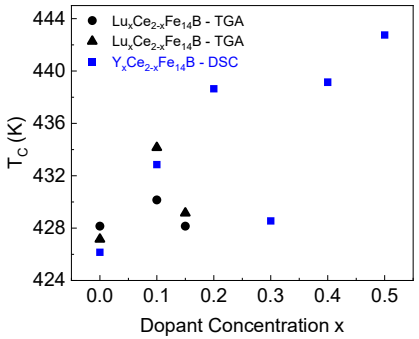
$Ce_2Fe_{14}B$ is **an attractive critical material free alternative** to $Nd_2Fe_{14}B$, however $Ce_2Fe_{14}B$ **displays rather low** T_C, H_a, and M_S. Chemical substitutions in $Ce_2Fe_{14}B$ can **improve** the magnetic properties.

T = 300 K	$Nd_2Fe_{14}B$ [1]	$Ce_2Fe_{14}B$ [1]
T_C	584 K	430 K
M_S	32 μ_B/f.u.	24 μ_B/f.u.
H_a	75 kOe	25 kOe

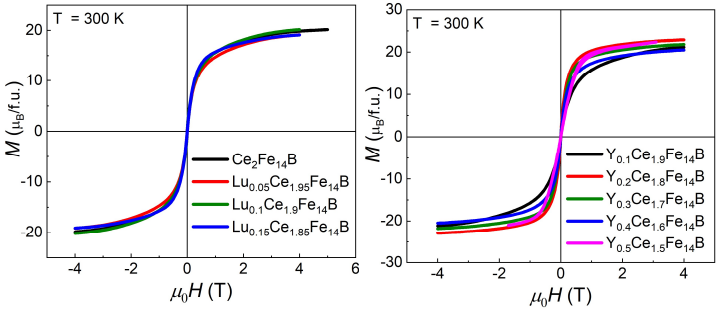
Lutetium and Yttrium doping in $RE_xCe_{2-x}Fe_{14}B$

XRD results demonstrated Lu and Y substitutions both **suppressed the growth** of the $CeFe_2$ Laves impurity phase and therefore, the primary and only impurity determined by XRD was α-Fe. Y also **lowered the percentage** of the α-Fe impurity compared with Lu substitutions.





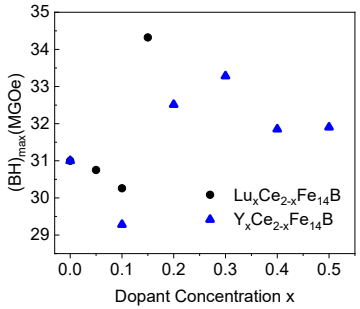
DSC/TGA measurements demonstrated Y doping **increased** T_C, while Lu had **little to no effect** on T_C.



Isothermal magnetization measurements revealed Y doping **increased** M_S, while Lu doping had **little to no effect** on M_S.

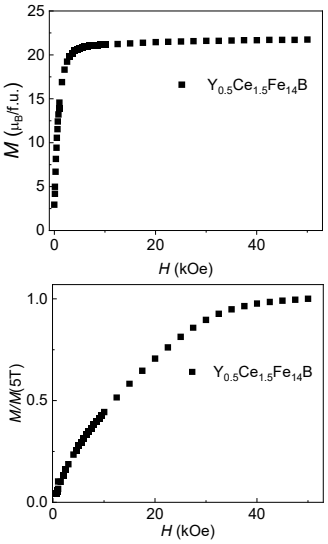
Results

Y doping **increased** M_S and T_C while **decreasing** impurities, enabling $Y_xCe_{2-x}Fe_{14}B$ magnets as potential critical material free high performance permanent magnets



Future Work

Complete anisotropic easy and hard axis magnetization measurements



Acknowledgements

Laboratory Directed Research and Development (LDRD) Program at Savannah River National Laboratory (SRNL).

References

[1] Herbst, J. F. "R 2 Fe 14 B materials: Intrinsic properties and technological aspects." (1991)

[2] Liu, Jun. "Microstructure and coercivity relationship of hot-deformed Nd-Fe-B anisotropic magnets." (2015).

SRNL-MS-2023-00454

Savannah River National Laboratory®