Phase Composition and Magnetic Properties of $Nd(Pr)_2Fe_{14}B$ and $(Sm,Zr)Fe_{11}Ti$ Magnets Produced by Selective Laser Melting

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THE AIM of this study is to evaluate the feasibility of additive manufacturing for producing permanent magnets and to experimentally establish the relationship between the magnetic hysteresis properties of single-layer samples and their synthesis conditions via **selective laser melting (SLM)**.

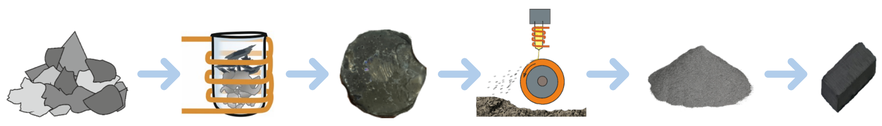
Related Oral Presentation
For an in-depth discussion, attend the talk:
O11-3 "Additive manufacturing of hard magnetic materials Nd2Fe14B and Sm(Fe,Ti,V)12"
July 30, 14:05

Why is SLM?

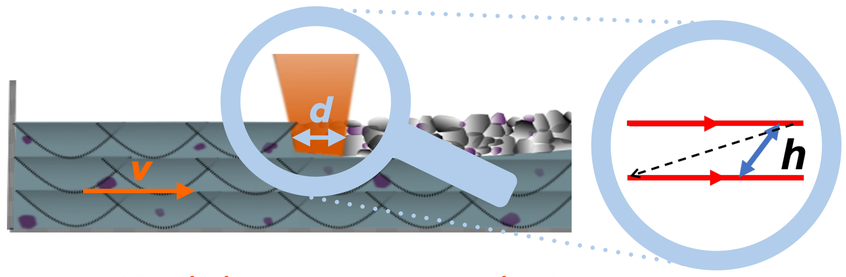
obtaining a fully dense magnet with coercivity exceeding that of the initial alloy, *without the use of an organic binder*

PROS	CONS
Any complex shape	*Special forms of powders*
Local varying of properties	*A large number of printing parameters*
Controlling of chemical composition	*Special requirements: persons and rooms*
Obtaining any microstructure	

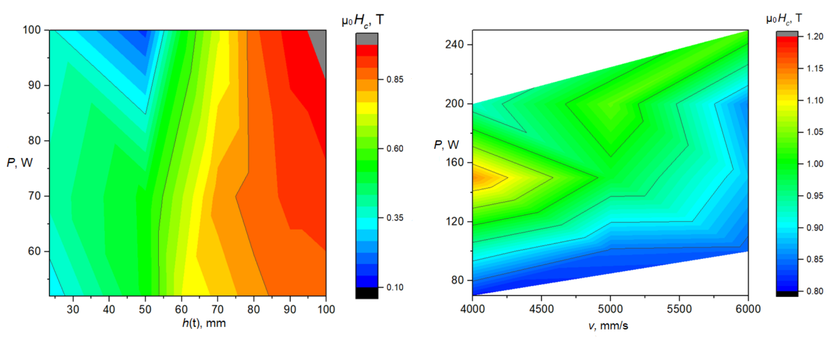
PARAMETERS & OPTIMIZATION



Preparation of powders for 3D-printing and reference samples



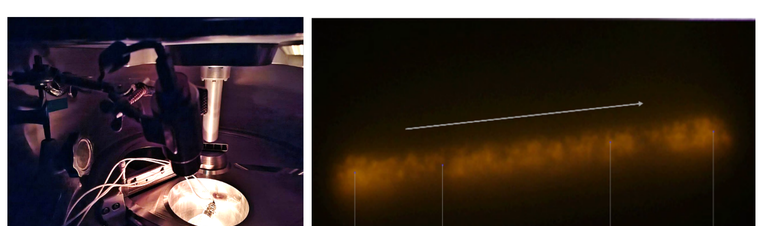
3D-printing: laser melts the mix of the powders



Coercivity maps of 3D-printed samples under different process conditions

PROBLEM

Excessively high temperature is detrimental to coercivity

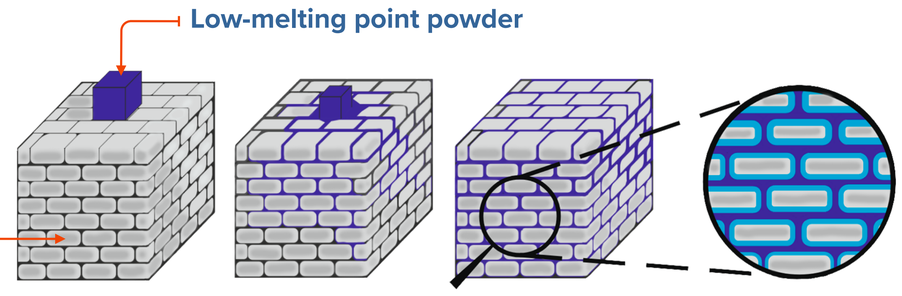


SOLUTION

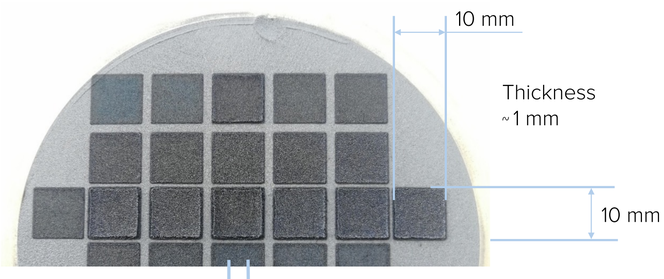
SLM using the mix of magnetic powder with low-melting point powder

MICROSTRUCTURE & MAGNETIC PROPERTIES

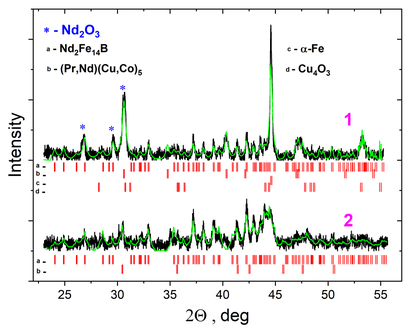
PROCESSES OF INFILTRATION

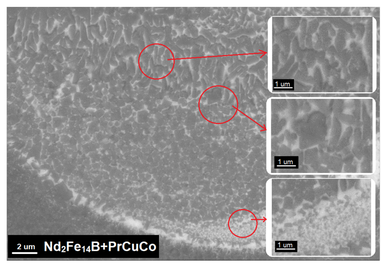


SPECIMENTS

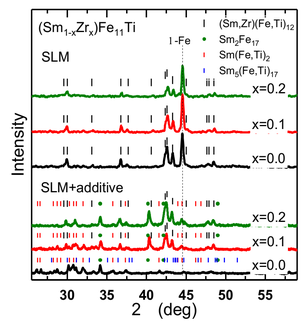


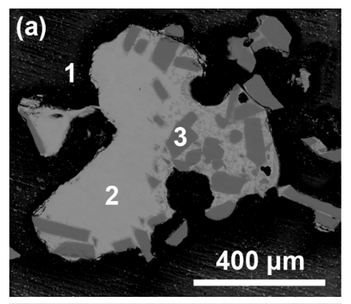
mixture of $MQP\text{-}B+Pr_{75}(Cu_{0,25}Co_{0,75})_{25}$

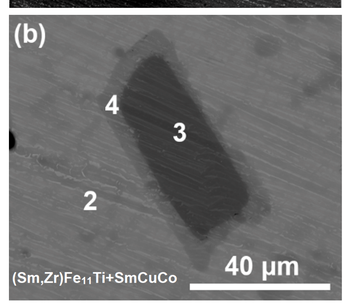




mixture of $(Sm,Zr)Fe_{11}Ti+Sm_{75}(Cu_{0,25}Co_{0,75})_{25}$

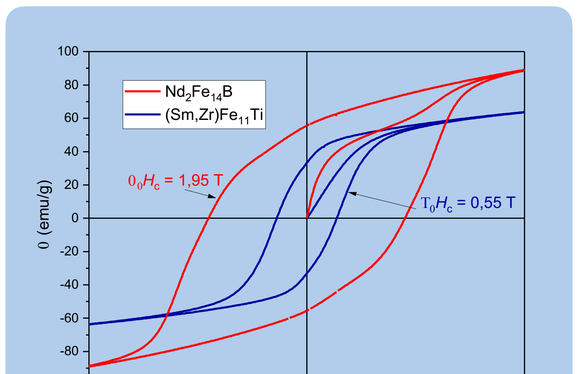






SLM-printed $(Sm,Zr)Fe_{11}Ti$ samples (x = 0.2)

1 - epoxy
2 - low-melting additive
3 - $(Sm_{1-x}Zr_x)Fe_{11}Ti$
4 - the area of interaction



KEY TAKEAWAYS

- **Selective laser sintering (SLS)** enables the synthesis of single-layer $Nd_2Fe_{14}B$ and $(Sm,Zr)Fe_{11}Ti$-based permanent magnets.
- **High coercivity** of **1.95 T** was achieved for **$Nd_2Fe_{14}B$** without post-synthesis annealing.
- **$(Sm,Zr)Fe_{11}Ti$** magnets showed lower coercivity (**0.55 T**) under similar conditions.

Ural Federal University

Research Gate
Viktoria Maltseva

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[1] A.S. Volegov et al., *Acta Materialia*, **188** (2020) 733-739
[2] D. Goll et al. Micromachines, **12** (2021) 538
[3] V. Maltseva et al. *PMM,* **123 (8)** (2022) 740-745
[4] D. Neznakhin et al. *JMMM,* **563** (2022) 169937
[5] O. Gutfleish et al. *Add. Manuf.*, **64** (2023) 103426