Nuclear and Magnetic Texture in $SrFe_{12}O_{19}$ Using Combined 2D Neutron and X-ray Diffraction

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We have demonstrated that texture can be induced in a material by controlling the precursor morphology.[1] The precursor material goes through a topotactic and to some extend isomorphic phase transition.[2] We have used this to prepare highly textured permanent magnets ($SrFe_{12}O_{19}$) from lath shaped goethite (FeOOH) and $SrCO_3$.[3]

In the presented study we have prepared pellets prepared from different FeOOH precursors and analysed the magnetic and nuclear texture using 2D X-ray (2D-XRD) and neutron (2D-ND) diffraction techniques as well as electron backscatter diffraction (EBSD). A key advance is demonstrated through Rietveld refinement of 2D neutron diffraction data, enabling independent and quantitative determination of nuclear and magnetic texture components within a unified refinement, see Figure 1.

Nuclear and magnetic texture development in $SrFe_{12}O_{19}$ permanent magnets is investigated with emphasis on the role of precursor morphology and its impact on texture formation mechanisms. All samples exhibit preferred orientation along the pressing axis; however, the magnetic texture is consistently sharper than the corresponding nuclear texture, highlighting the role of magnetic interactions in texture sharpening. Bulk texture analysis from 2D-XRD reveals high global texture corroborate with local EBSD information, while 2D-ND provides complementary information due to its sensitivity towards magnetic ordering. For single-precursor systems, precursor morphology strongly governs the resulting texture, and samples exhibite sharp textures and improved magnetic alignment.

In mixed-precursor systems, multiple texture components are observed but do not combine linearly. Instead, the introduction of isotropic particles weakens the overall crystallographic texture disproportionately, while simultaneously enhancing the magnetic coercivity. This deviation from linear texture superposition indicates that texture evolution is not governed solely by rigid body rotation during processing. Rather, the results support a mechanism closer to templated grain growth, where precursor morphology influences both nucleation and growth pathways.

The study highlights the importance of combining complementary 2D diffraction techniques for robust texture quantification and demonstrates that subtle differences between nuclear and magnetic textures provide critical insight into texture formation mechanisms. These findings establish a framework for tailoring texture in permanent magnets through precursor design and processing strategies.

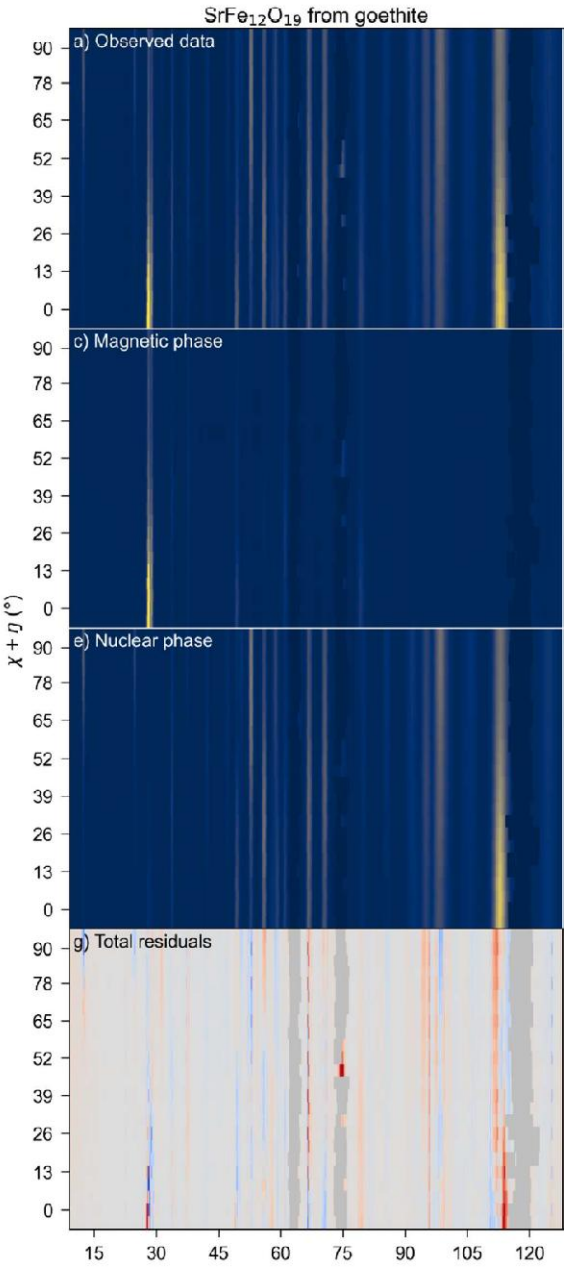


Figure 1 *Heatmap from 2D neutron diffractograms and Rietveld fits, for $SrFe_{12}O_{19}$ prepared from goethite.*

[1] J. Thomas-Hunt *et al.* Dalton Trans. (2022) 51, 3884–3893
[2] M. I. Mørch *et al.* Chem. Mater. (2024) 36, 1919−1927
[3] A. P. Laursen, *et al.* Adv. Electron. Mater. (2024) 10, 2400077

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