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Spark Plasma Sintered Manganese Substituted Strontium M-type Nano-hexaferrite

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Introduction

La-Co substituted hexaferrites are the most performant ferrites in the market of permanent magnets [1]. However, La and Co belong to the family of rare earth and strategic elements and to avoid their usage, nanostructuring ferrites which improve high H_c [2] is being studied as a possible alternative.

Nanopowders of manganese substituted strontium M-type hexagonal ferrites $SrM_xFe_{12-x}O_{19}$ with $x=1$ to 6 were successfully synthesized using the citrate precursor sol-gel method [3,4]. The obtained nanopowders were calcined at 950°C and then were Spark Plasma Sintered at 800°C. XRD analysis at room temperature and magnetometry in a maximum field of 6 T at temperatures ranging from 5 to 375 K were performed on the nanopowders as well as on their sintered pellets.

Methods and Materials

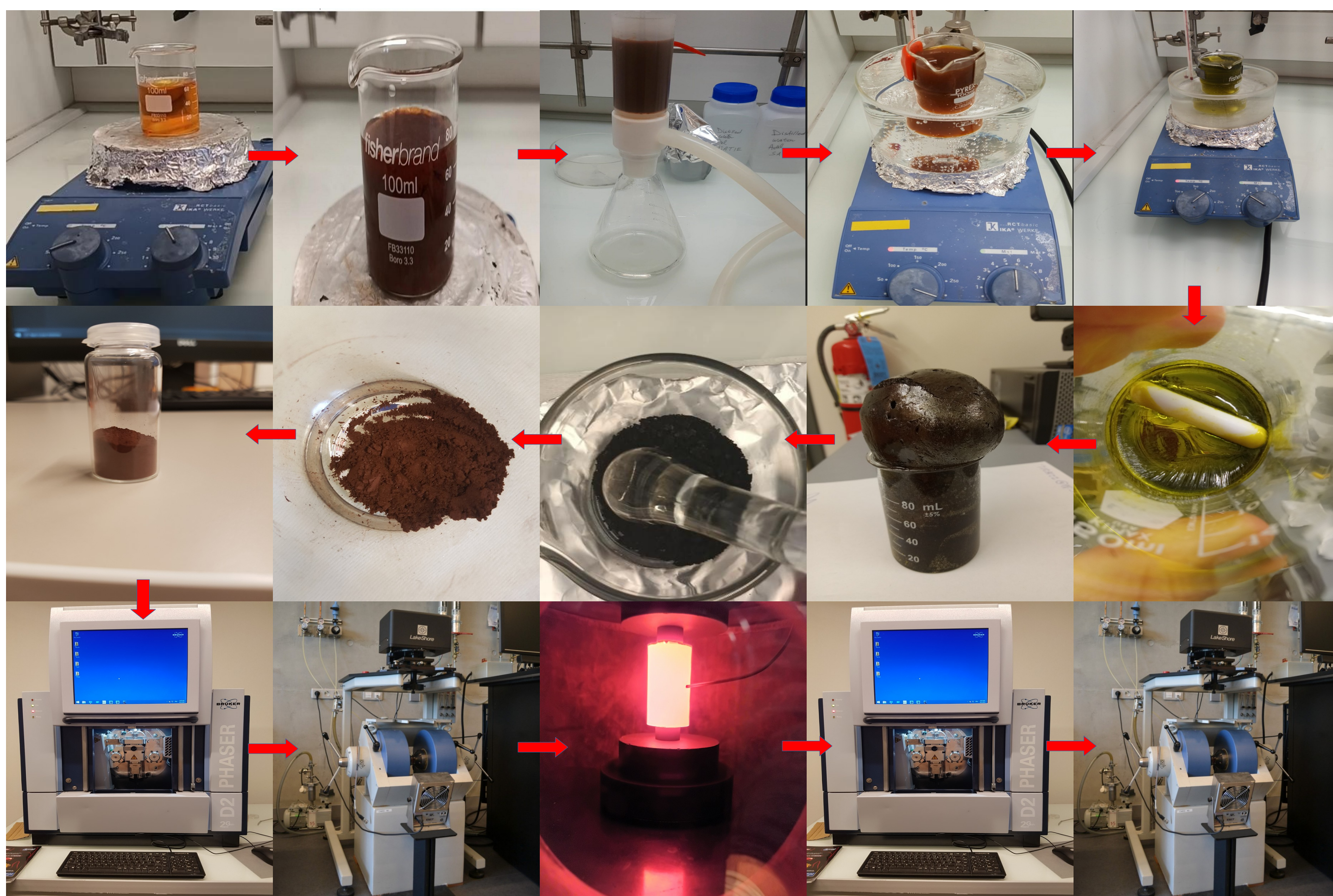


Fig. 1: The different steps of the citrate precursor sol-gel synthesis method of the hexaferrite nanopowders and the sintered pellets.

Structural analysis

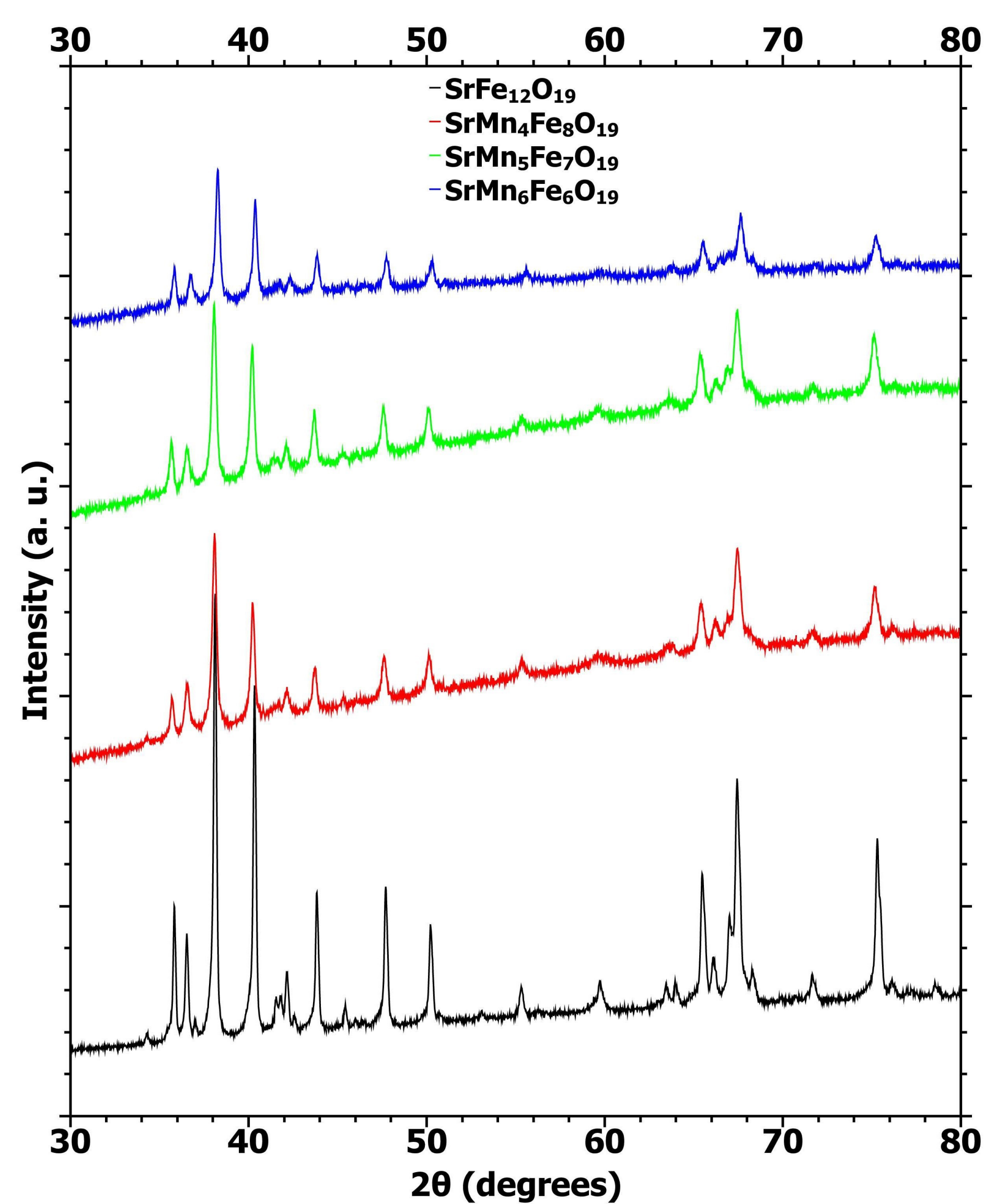


Fig. 2: XRD patterns of SPS Mn substituted SrM hexaferrite compared to a monophasic SPS SrM hexaferrite XRD pattern.

Magnetic properties

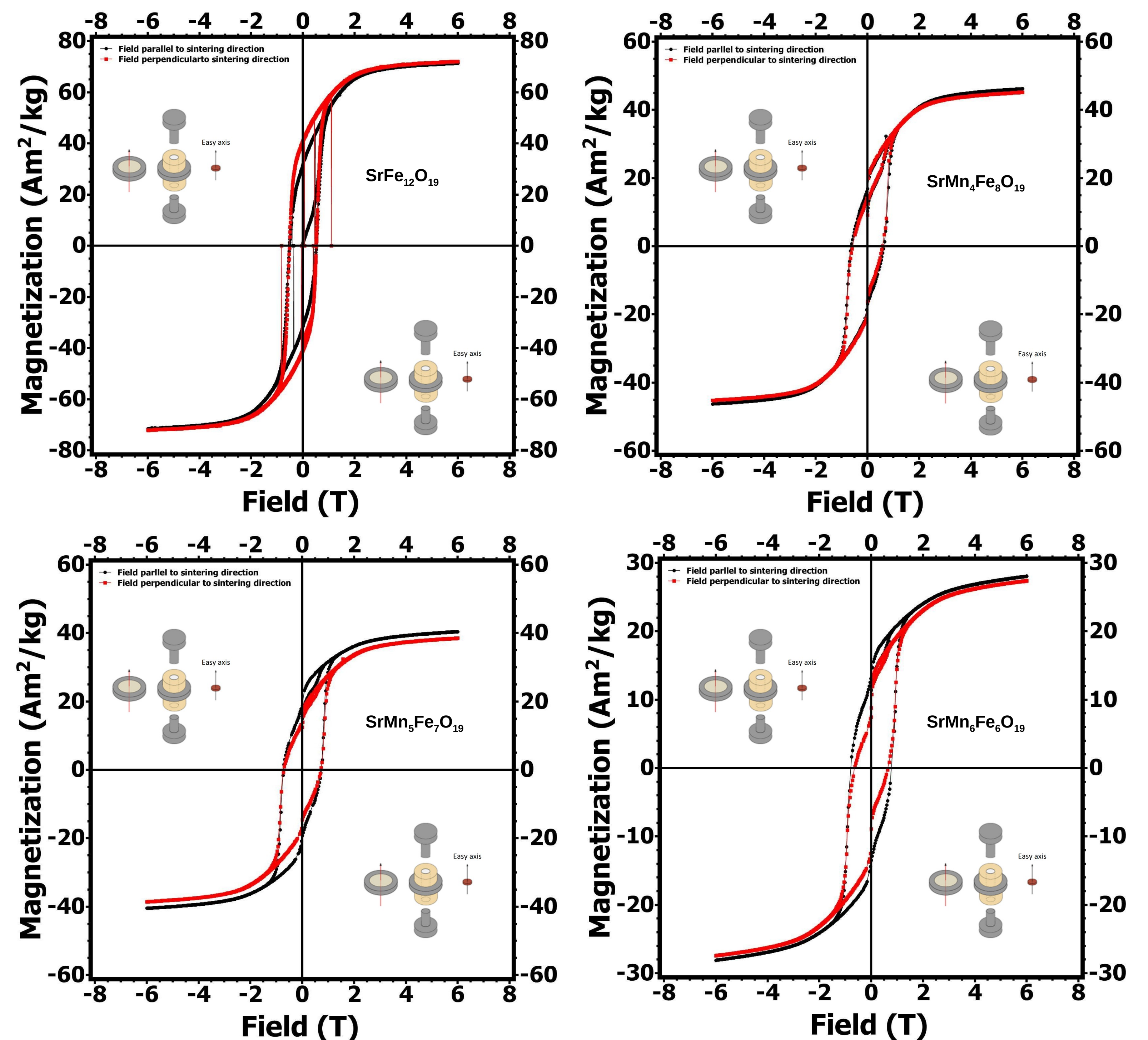


Fig. 3: M-H loop of Mn substituted SPS SrM hexaferrite pellets measured in the easy and hard axes.

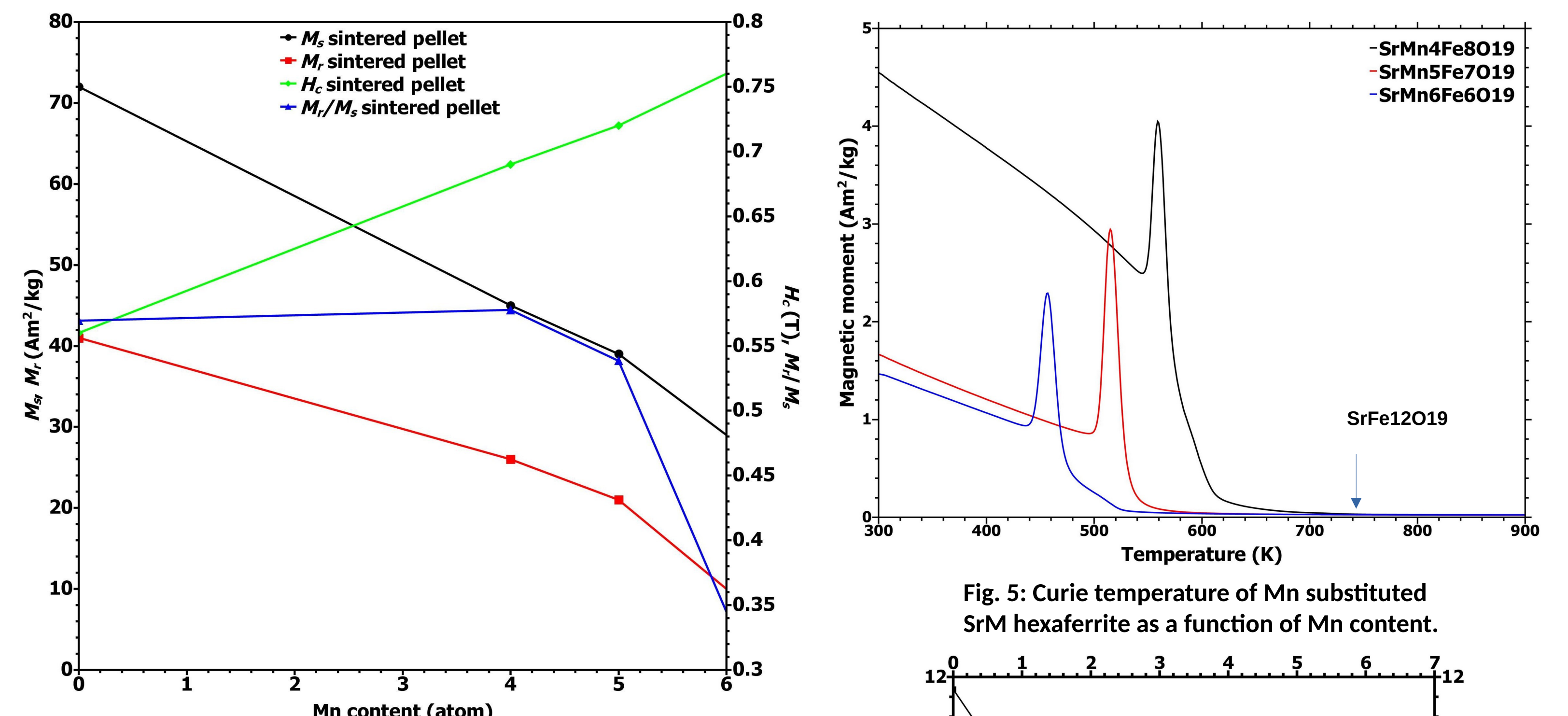


Fig. 4: Magnetic properties (M_s , M_r , H_c and M_r/M_s) of Mn substituted SrM hexaferrite as a function of Mn content.

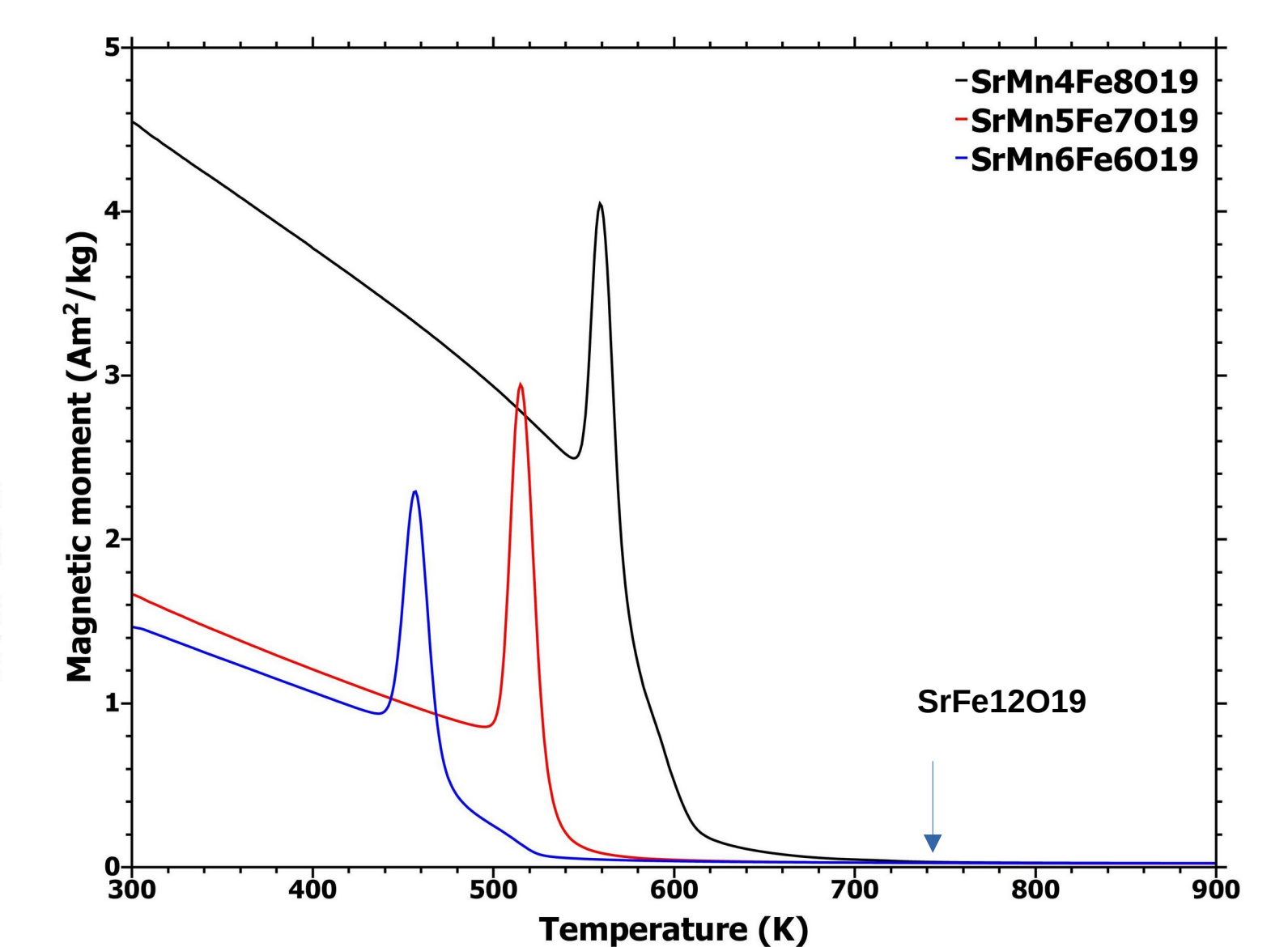


Fig. 5: Curie temperature of Mn substituted SrM hexaferrite as a function of Mn content.

Fig. 7: BH_{max} of Mn substituted SrM hexaferrite as a function of Mn content.

Conclusions

- M_s , M_r , H_c and M_r/M_s decrease by increasing the Mn content
- SPS presumably partially decomposes M ferrite into spinel (reduction of Mn3+)
- Coercivity increases reaching as high as 0.76 T in the sintered ($SrMn_6Fe_6O_{19}$) pellet.
- Coercivity drastically decreases after sintering reaching 67% of the coercivity of the starting loose powder for $x=6$

References

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