

From first-order magneto-elastic to magneto-structural transition in $(\text{Mn},\text{Fe})_{1.95}\text{P}_{0.50}\text{Si}_{0.50}$ compounds

Nguyễn Hữu Dũng, Lian Zhang, Zhiqiang Ou, Ekkes Brück

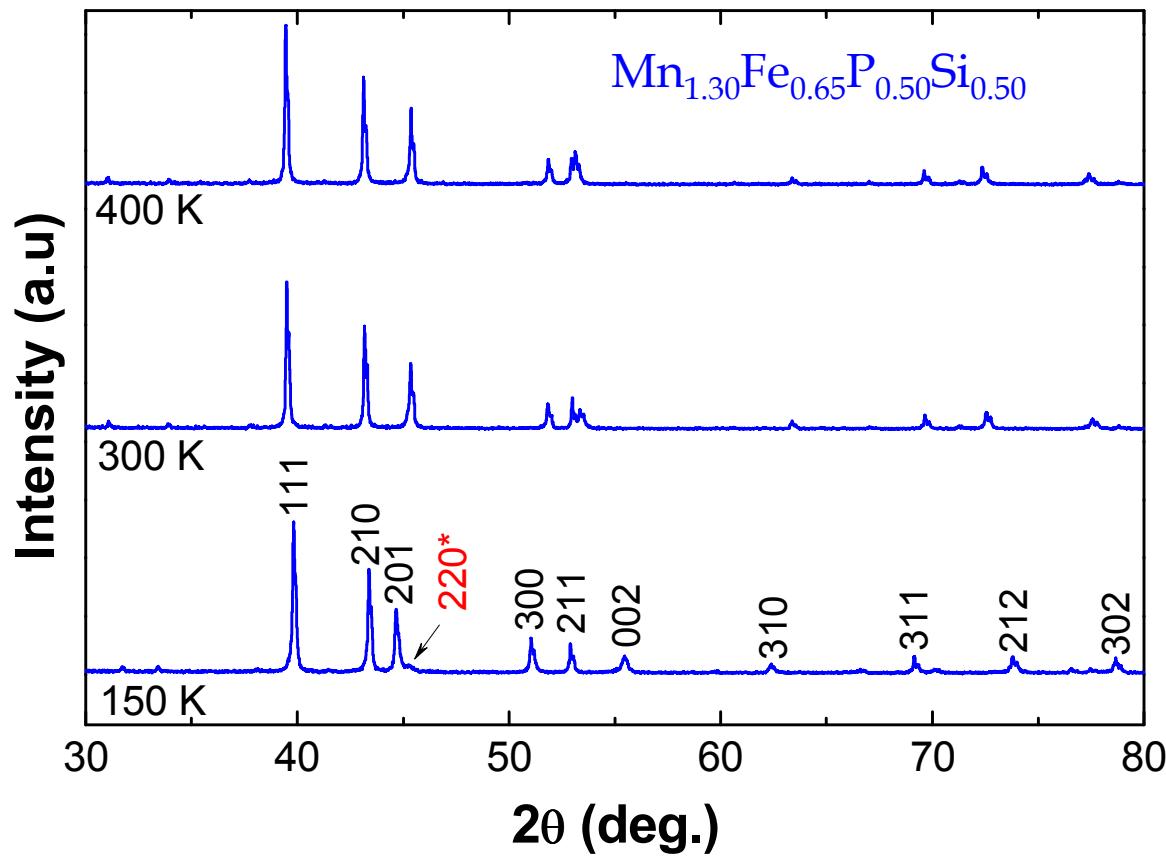
Fundamental Aspects of Materials and Energy (FAME),
Faculty of Applied Sciences,
Delft University of Technology

First-order magneto-structural transition:

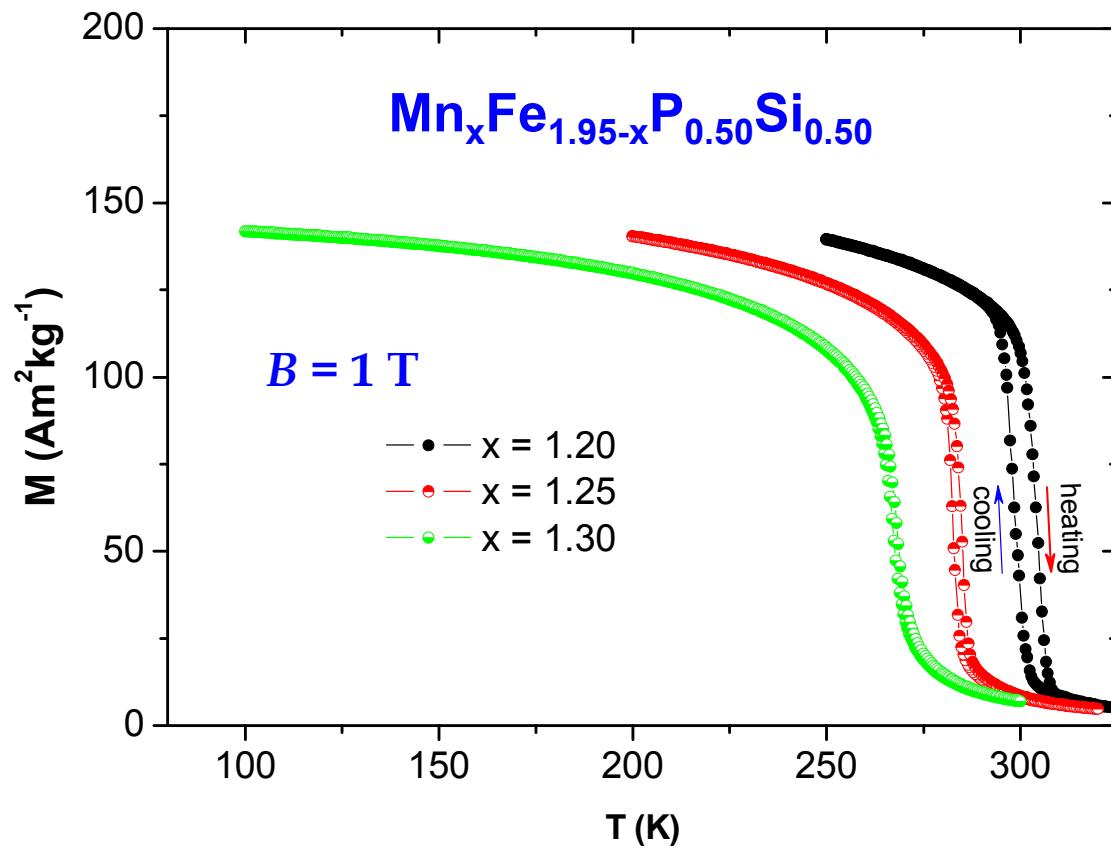
- $\text{Gd}_5(\text{Ge}_x\text{Si}_{1-x})_4$
- $\text{Ni}_{0.50}\text{Mn}_{0.50-x}\text{Sn}_x$

First-order magneto-elastic transition:

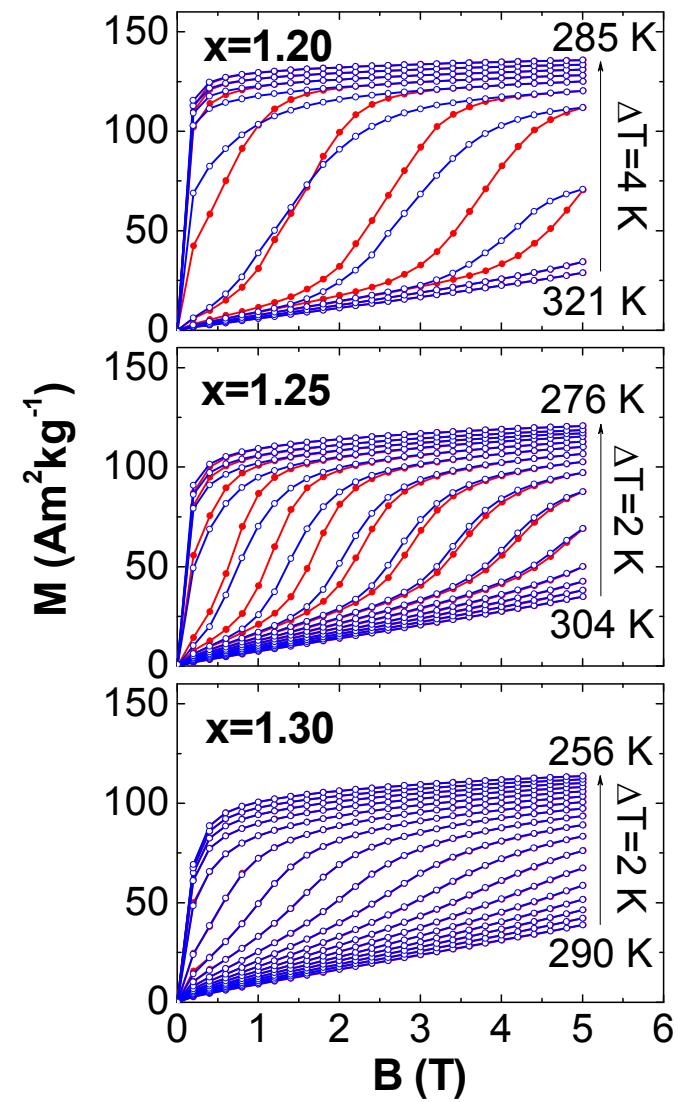
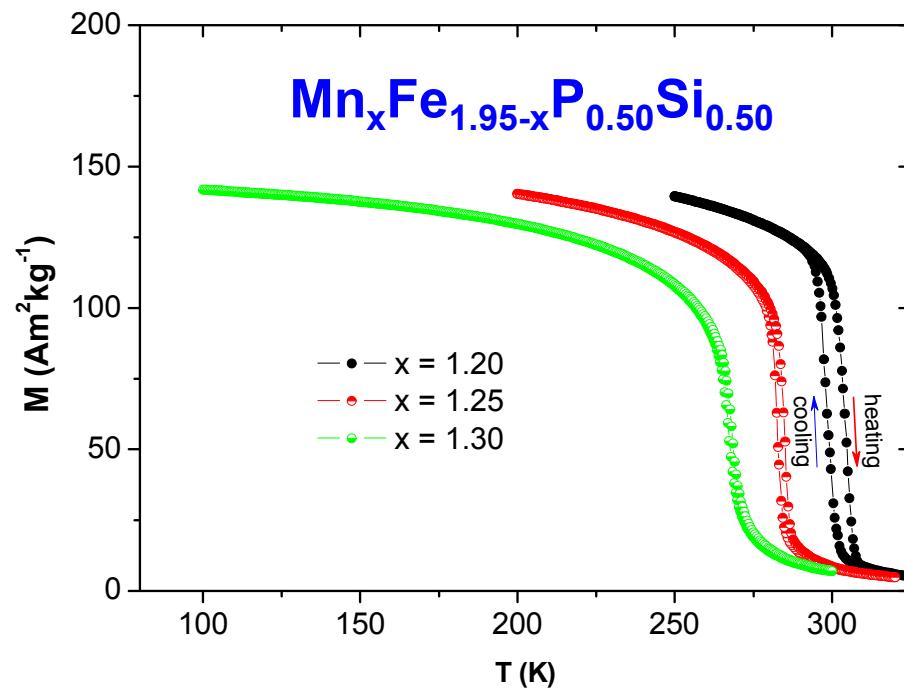
- $\text{MnFeP}_{1-x}\text{As}_x$
- $\text{La}(\text{Fe}_{1-x}\text{Si}_x)_{13}$



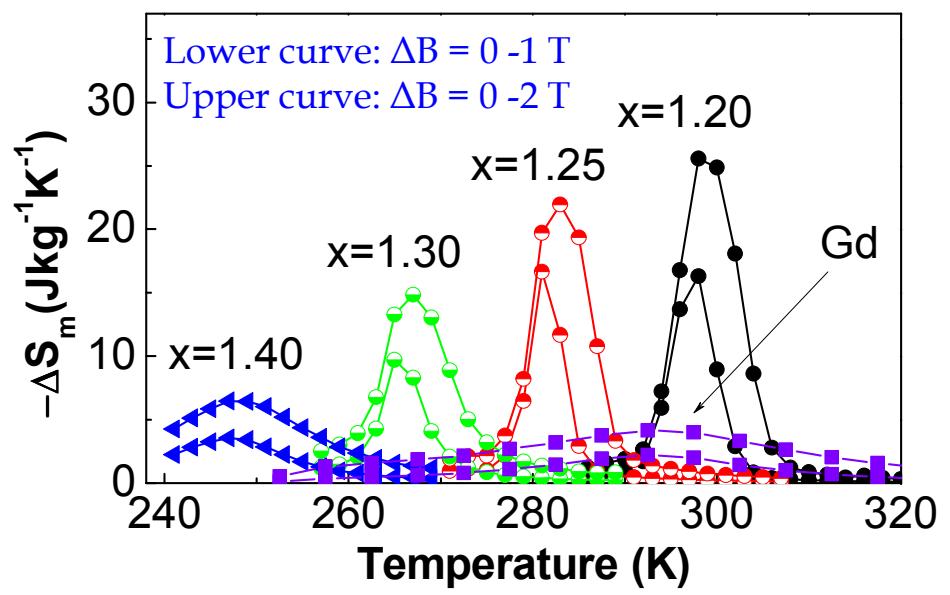
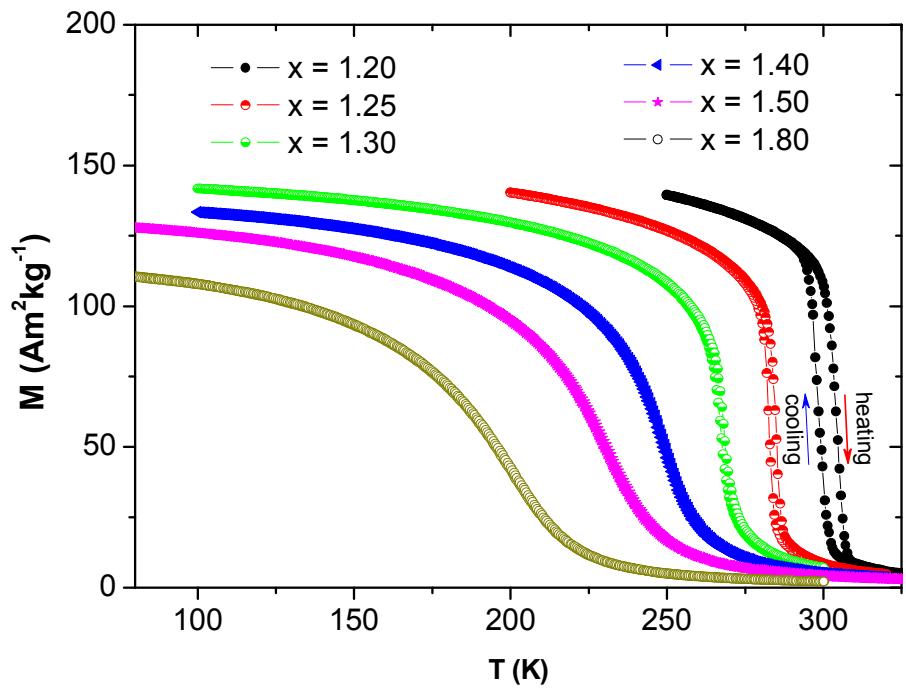
- Hexagonal Fe_2P -type structure
- A very small amount of cubic $(\text{Mn},\text{Fe})_3\text{Si}$ impurity (hkl Miller index with asterisk (*) in red color).



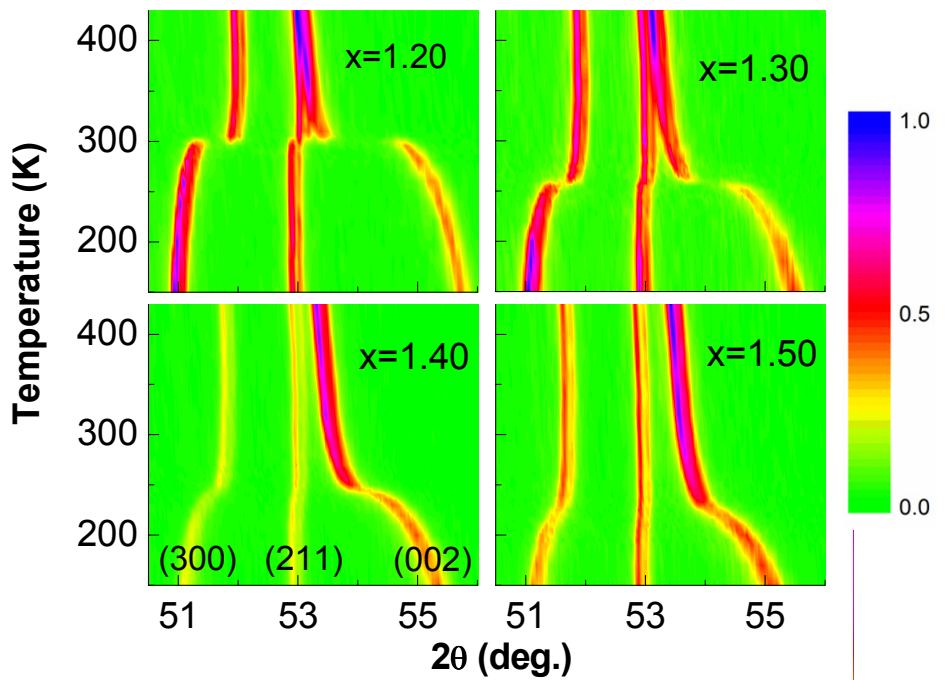
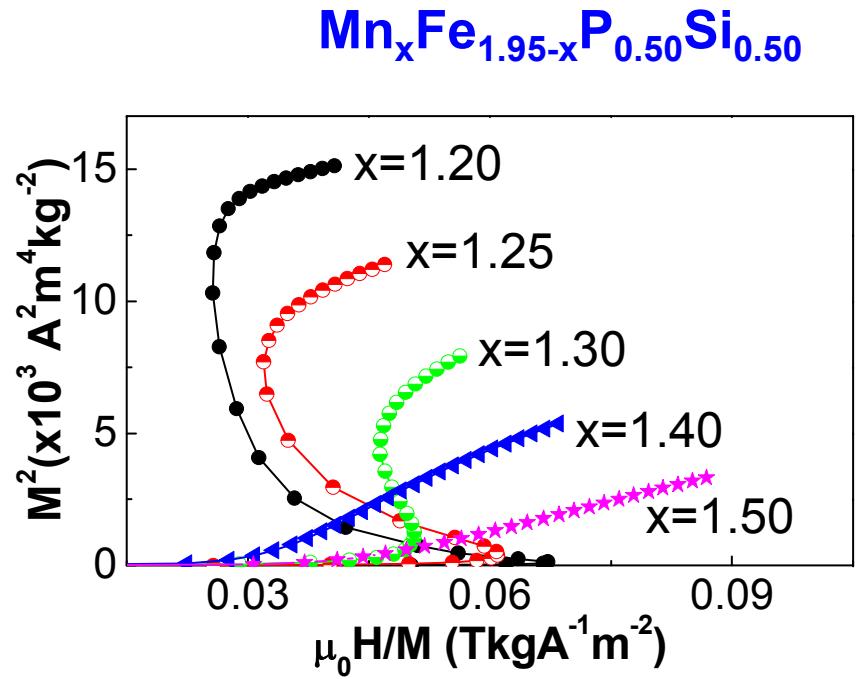
- Sharp ferro-paramagnetic transition
- Hysteresis

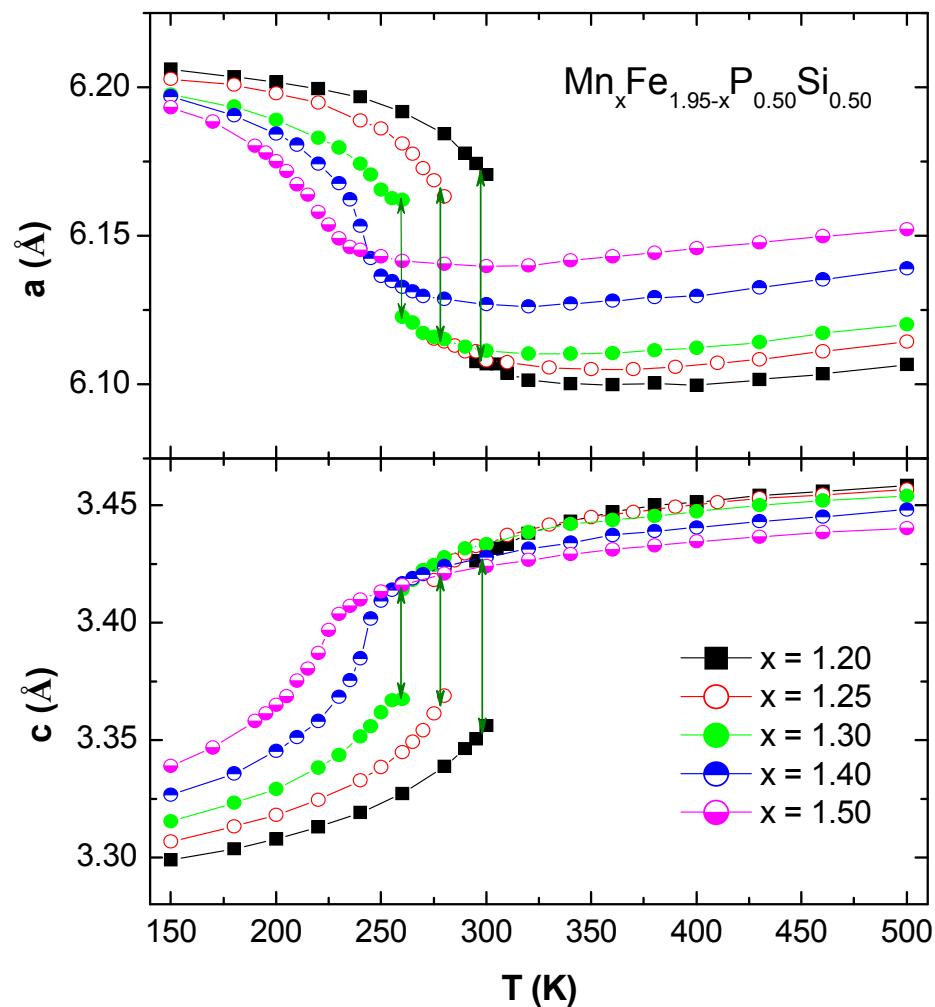


- Thermal hysteresis is correlated with magnetic hysteresis

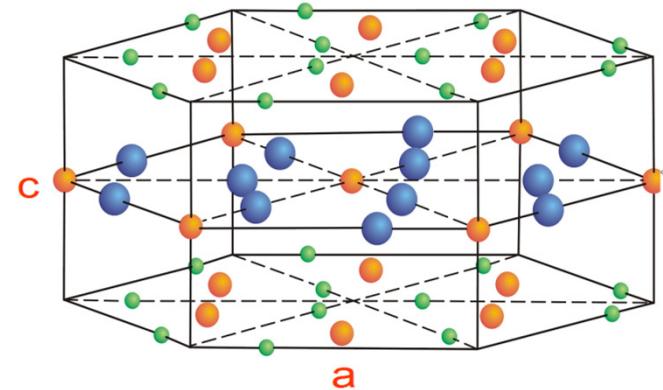


Mn_xFe_{1.95-x}P_{0.50}Si_{0.50}



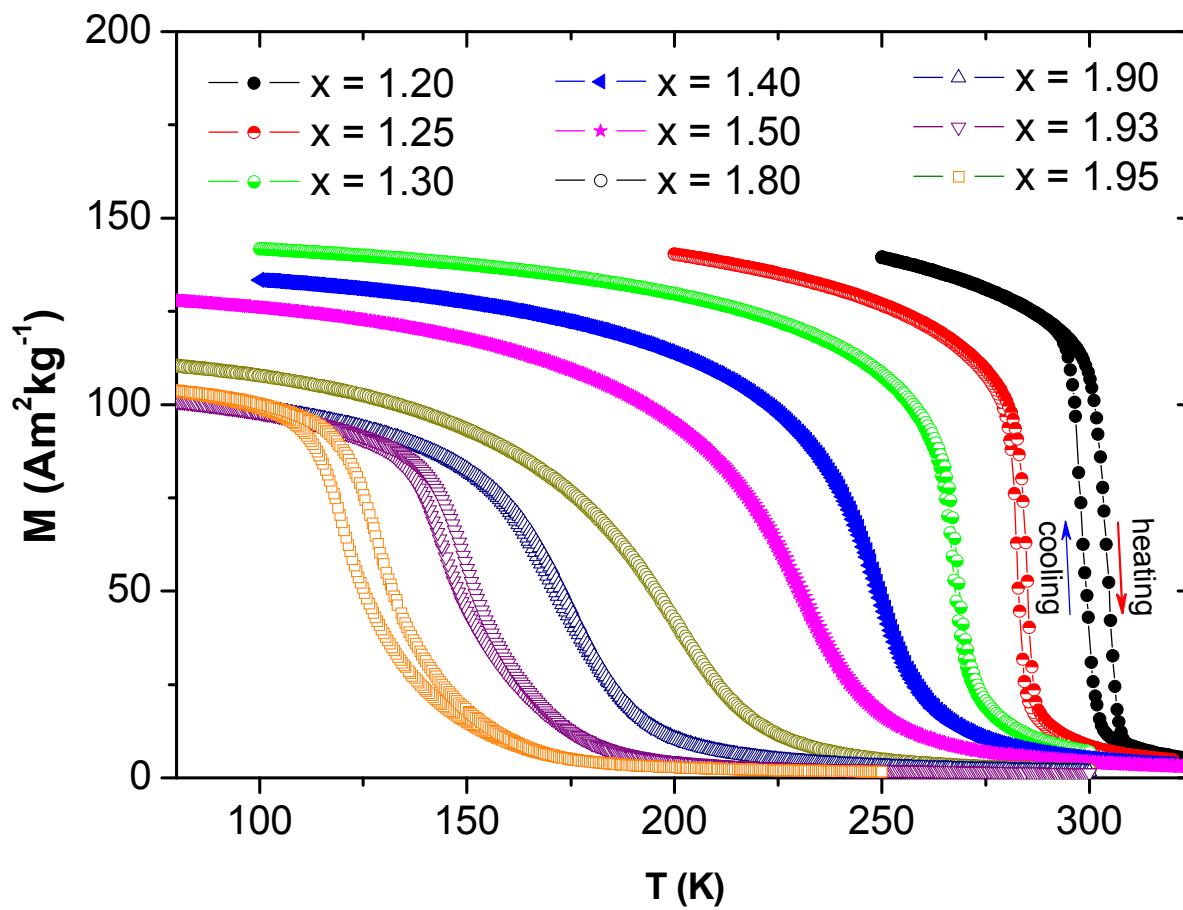


$\text{Mn}_x\text{Fe}_{1.95-x}\text{P}_{0.50}\text{Si}_{0.50}$



- Discontinuous change of the lattice parameters a and c is correlated with hysteresis

$\text{Mn}_x\text{Fe}_{1.95-x}\text{P}_{0.50}\text{Si}_{0.50}$



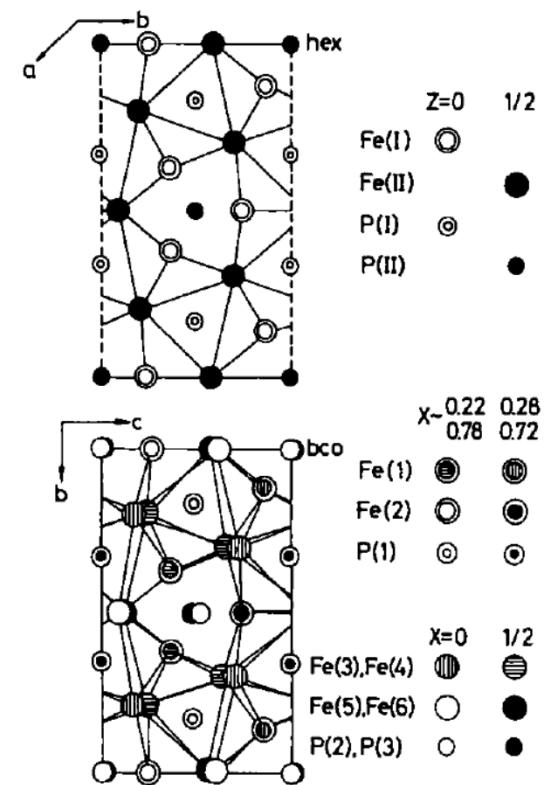
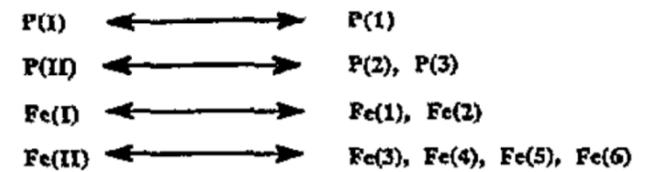
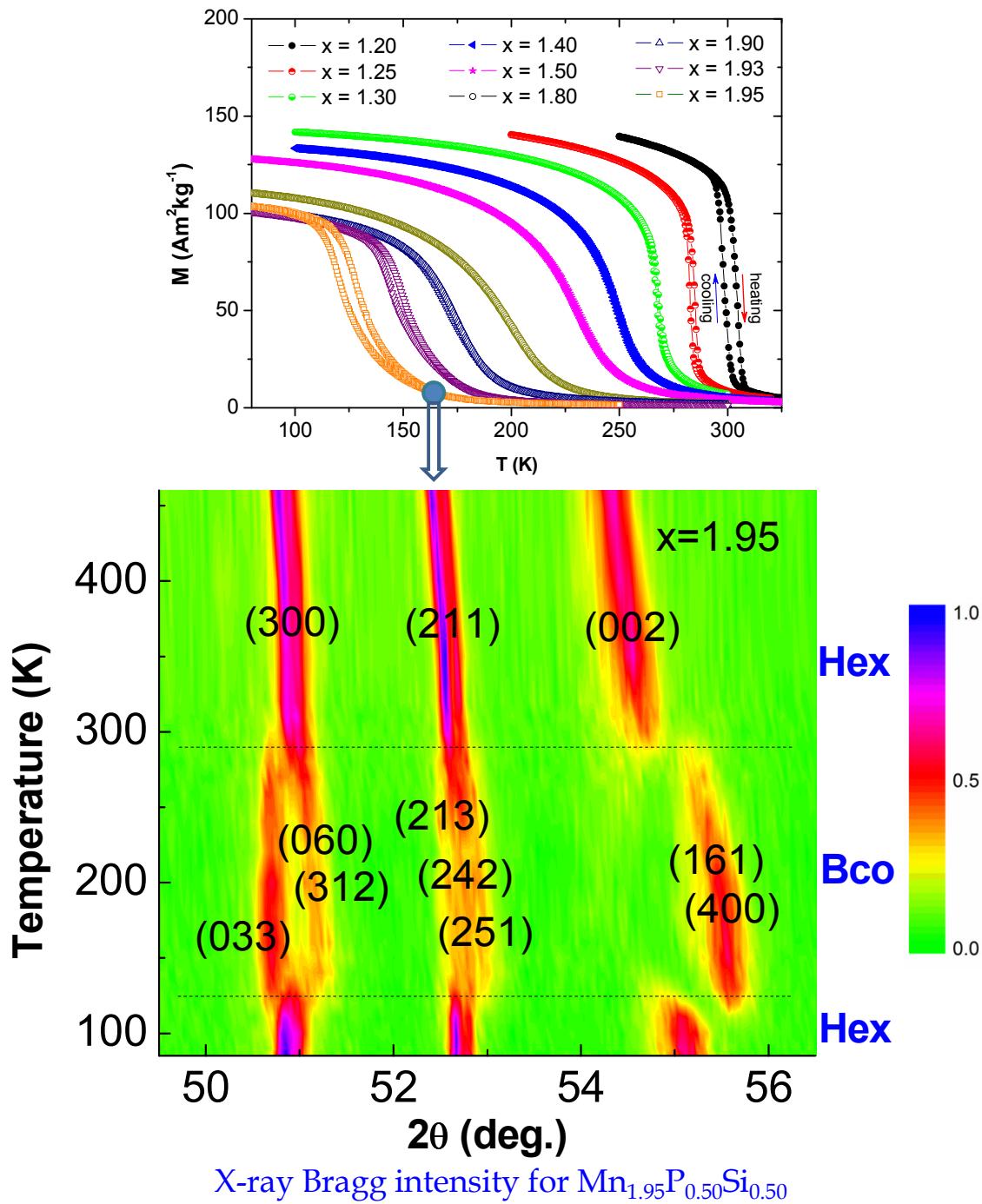
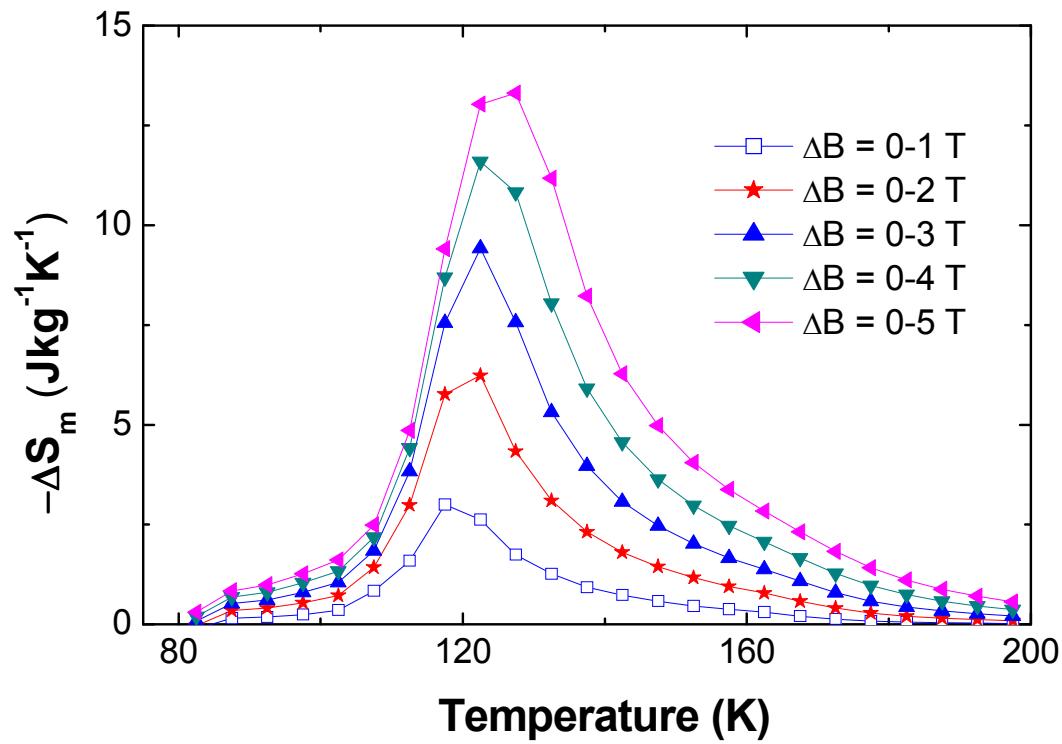


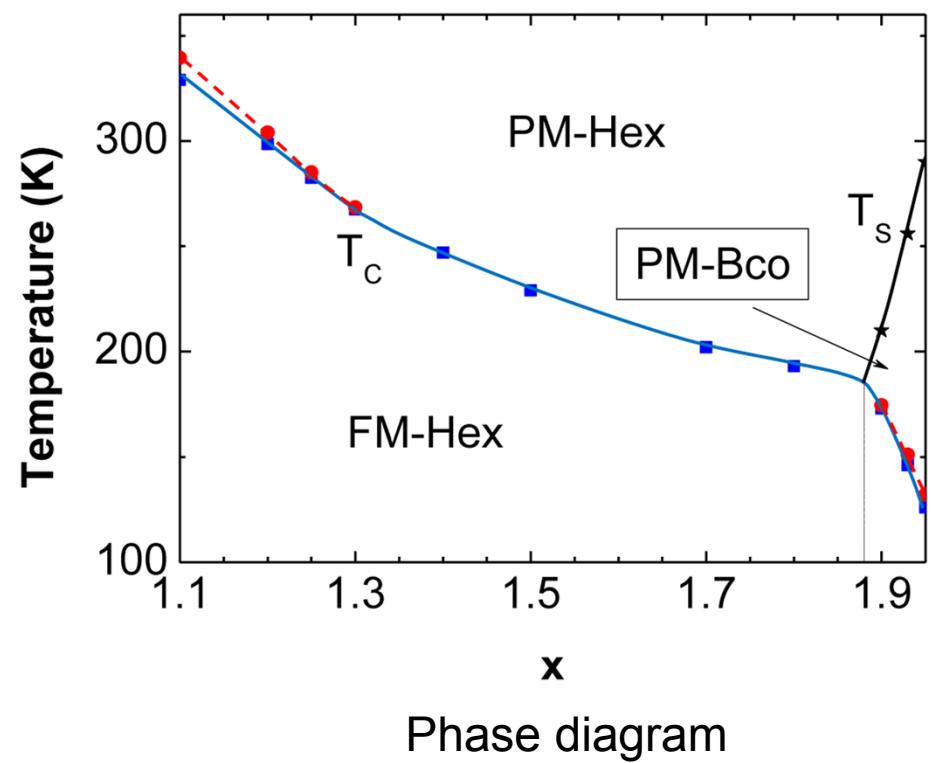
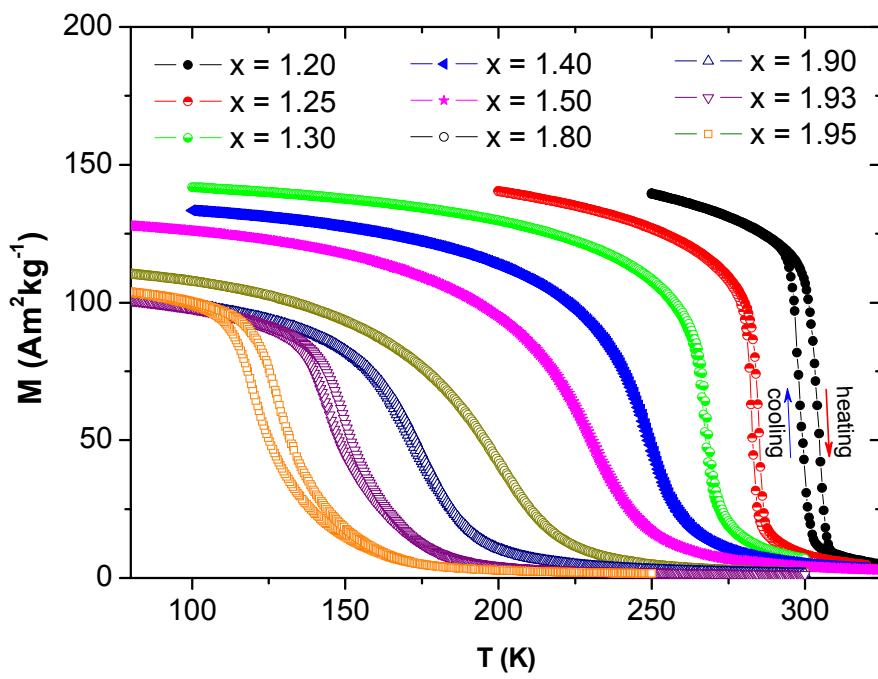
Fig. 2. Projections of the hexagonal and the orthorhombic (bco) phase of Fe_2P .

L. Häggström et al., Hyperfine Interactions 94, 2075 (1994)



Magnetic entropy change of $\text{Mn}_{1.95}\text{P}_{0.50}\text{Si}_{0.50}$

$\text{Mn}_x\text{Fe}_{1.95-x}\text{P}_{0.50}\text{Si}_{0.50}$



Conclusion

- $\text{Mn}_x\text{Fe}_{1.95-x}\text{P}_{0.50}\text{Si}_{0.50}$ with $x < 1.40$ exhibits a first-order magneto-elastic transition.
- Small thermal hysteresis ($< 1 \text{ K}$) and negligible magnetic hysteresis can be obtained while maintaining a giant magnetocaloric effect.
- A second-order magnetic transition for $x \geq 1.40$
- A first-order hexagonal – orthorhombic magneto-structural transition for $x \geq 1.88$

Thank you for your attention