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Temperature dependence of the crystal structure and magnetic properties of $MnFe_4Si_3$ at high pressures

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Refrigeration based on the magnetocaloric effect is a potential alternative to conventional vapor compression refrigeration. One system of particular interest with regard to application is $Mn_{5-x}Fe_xSi_3$ [1-3]. Pressure affects the interatomic distances in the crystal structure and thus has an influence on the magnetic properties.

The aim of this work is to establish the influence of hydrostatic pressure on the crystal structure of $MnFe_4Si_3$ as well as the pressure dependence of the magnetic transition of $MnFe_4Si_3$, which at ambient pressure orders ferromagnetically at $T_C \approx 300$ K. Synchrotron X-ray powder diffraction measurements were carried out up to 12.5 GPa between 100 K and 373 K. Isofield magnetization measurements and neutron single-crystal diffraction were used to determine the magnetic transition temperature up to pressures of 1 GPa.

$MnFe_4Si_3$ shows no clear indication of phase transitions at high temperatures (296 K–373 K) and high pressures. At low temperatures (200 K, 250 K), anomalies in the lattice parameters occur as a function of pressure. They might be related to a transition into a magnetically ordered phase. The trend of decreasing magnetic transition temperature with increasing pressure is also observed in magnetization data and in the intensities of selected magnetic reflections from neutron diffraction experiments at 1 GPa. The pressure-dependent unit cell volume data at 100 K and 150 K exhibit anomalies as two equations of state are necessary to fit each of the data sets, respectively.

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