The magnetic structure of Fe$_2$P-related compounds prepared by the drop synthesis method

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Fe$_2$P and related compounds (Ni$_2$P; (Fe,Mn)$_2$P,Si) need a synthesis technique to prevent evaporation of the volatile elements Mn and P. The “drop synthesis method” makes it possible to synthesize compounds containing volatile elements by using an induction furnace.

Single phase samples of nominal composition FeMnP$_{0.5}$Si$_{0.5}$ have been prepared by the drop synthesis method. The crystallographic and magnetic structures of FeMnP$_{0.5}$Si$_{0.5}$ have been studied by means of neutron and X-ray powder diffraction and the magnetocaloric effect has been estimated by magnetic measurements. The compound crystallizes in the Fe$_2$P-type structure (P-62m) with the magnetic moments aligned along the a-axis, see Figure 1. It was found from structural refinements using the Rietveld method that the Fe atoms are mainly situated in the tetrahedral 3g site and the Mn atoms prefer the pyramidal 3f position.

The material is ferromagnetic (T$_C$ = 382 K) and at 296 K the total magnetic moment is 4.4 $\mu_B$/f.u. The magnetic moment in the 3f site is larger (2.5 $\mu_B$) than in the 3g site (1.9 $\mu_B$). The magnetocaloric properties are relatively large and the magnetic entropy change was estimated from magnetization data. For a magnetic field change of 1.8 T, a magnetic entropy change of about 18 J/kgK is obtained, see Figure 2.

![Figure 1: Magnetic entropy change for FeMnP$_{0.5}$Si$_{0.5}$ estimated from magnetization measurements.](image)

![Figure 2: The magnetic structure of FeMnP$_{0.5}$Si$_{0.5}$](image)