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Effect of pressure on magnetic state of iron borate

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Magnetization processes in weakly ferromagnetic iron borate single crystals under uniaxial external pressure applied in basal plane at room temperature have been investigated. The shape of magnetization curves has been shown to depend on the applied pressure value. This dependence evidences the appearance of induced uniaxial magnetic anisotropy with easy axis parallel to the pressure direction. The sample magnetization as a function of pressure curve has been analyzed. The curve character demonstrates existence of two phases during magnetization process. Experimental results been obtained are in good correlation with existing theory.

Экспериментально исследованы процессы намагничивания слабоферромагнитных монокристаллов бората железа, подверженных внешнему одноосному давлению в базисной плоскости при комнатной температуре. Показано, что форма кривых намагничивания зависит от величины приложенного давления. Эта зависимость свидетельствует о возникновении наведенной одноосной магнитной анизотропии с легкой осью, параллельной оси давления. Изучена кривая зависимости намагниченности образца от приложенного давления. Характер кривой говорит о существовании двух фаз в процессе намагничивания. Полученные экспериментальные результаты коррелируют с существующей теорией.

Iron borate, $FeBO_3$, single crystal is an antiferromagnet with weak ferromagnetism and magnetic anisotropy of "easy plane" type. Two magnetic sublattices are arranged in an almost antiparallel manner. The canting angle between sublattice magnetization vectors lying in basal plane of the crystal is about one degree and is responsible for the weak ferromagnetic moment (Fig. 1). The $FeBO_3$ crystal lattice can be described by spatial symmetry group of rhombohedral system D_{3d}^6 (Fig. 1). Being grown from solution in melt, the samples are shaped as basal plates of 50 to 100 μm thickness.

Strong magnetostrictive effects in the iron borate crystals cause in many cases a non-controllable influence of mechanical boundary conditions on experimental results. In [1], magnetic birefringence of transversal sound passing through iron borate along C_3 axis at 77 K was investigated. The stresses caused by hard contact between piezotransducers and the crystal surface cannot be measured directly. So, a theoretical model was constructed including magnetic anisotropy induced by the stresses. The theory developed basing on the model describes the experiment satisfactorily. In [2], uniaxial stresses in $FeBO_3$ plate were induced intentionally by deforming the glass substrate of the crystal. Striated domain structure observed in this case evidenced the induced magnetic anisotropy appearance.

In this work, magnetization processes in iron borate single crystals under external uniaxial pressure were investigated at room temperature. Iron borate exhibits a considerable Faraday rotation in visible spectral range. The Faraday effect is known to be proportional to the longitudinal magnetization component. In this connection, a magnetooptical magnetometer (Fig. 2) was constructed to study the magnetization processes in experiment. The synthesised basal $FeBO_3$ plates of up to 100 μm thickness