

# Magnetic Alignment of Nonferromagnetic Oxides Achieved at Low Field Intensity Due to High Concentration of Paramagnetic Ions

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Micron-sized single crystals of oxide minerals dispersed in ethanol showed magnetic alignment at low field intensity when concentrations of paramagnetic ions were high. The alignments were due to anisotropy of paramagnetic susceptibility. The field of alignment  $B_s$  observed for biotite grains, having a paramagnetic susceptibility of  $4.4 \times 10^{-5} \text{ emu/g}$ , was  $B_s = 210$  Gauss;  $B_s$  was 600 Gauss for muscovite grains having the paramagnetic susceptibility of  $4.8 \times 10^{-6} \text{ emu/g}$  [1]. Magnetic alignments at such low fields are not seen in the literatures for non-ferromagnetic oxide minerals. The measured  $B_s$  values of diamagnetic fluorophlogopite previously reported were as large as 36,000 Gauss; alignment was caused by diamagnetic anisotropy for fluorophlogopite. Biotite and fluorophlogopite have similar crystal structures, which means that both crystals have similar amount of diamagnetic anisotropy. Biotite is expected to have a  $B_s$  value similar to that of phlogopite if its paramagnetic anisotropy is not strong.

Attempts have been made to apply magnetic alignment in material processing such as in crystal growth or in processing aggregates of polycrystalline with their crystalline axes aligned in one directions; 2) the process required strong magnetic field produced by a superconducting magnet. Reduction of  $B_s$  mentioned above may increase the variety of practical applications as well as the possibility of utilizing the alignment phenomenon. It is essential to increase the paramagnetic ions of the crystal as well as to evaluate the magnetic anisotropy assigned to local paramagnetic sites in the course of designing and processing a material.

[1] Jpn.J.Appl.Phys.44 (2005) in print.