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IMPURITIES IN NATURAL $MgAl_2O_4$ SPINEL: EPR STUDY

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The properties of spinel are strongly affected by impurities and, sometimes, cannot be revealed by optical methods. Electron paramagnetic resonance (EPR) is a sensitive spectroscopic tool for studying electronic structures, dynamics, and spatial distribution of paramagnetic species in solids. EPR directly focuses on the unpaired electrons, and is therefore the method of choice for studying free radicals and triplet states in compositions with transition metals, rare earth ions, and defect centers.[1] This work presents the EPR (9.2 GHz, X-band) spectroscopy as an useful probe for revealing and studying the impurities in two natural spinels, $MgAl_2O_4:Cr^{3+}$ and $MgAl_2O_4:(Cr^{3+},Mn^{2+})$. The impurities were not revealed completely when studying the same samples by photoluminescence spectroscopy.[2]

The $MgAl_2O_4:Cr^{3+}$ compound showed three resonance lines at 30, 170, and 335 mT, respectively (see Fig. 1). An asymmetrical resonance line at 170 mT is caused by the +1/2↔-1/2 electron transition of Cr^{3+} ions. This line was unchanged in the temperature range studied. Two other lines are probably related to the interaction between electrons of Cr^{3+} ions and the host lattice or defects.

For the $MgAl_2O_4:(Cr^{3+},Mn^{2+})$ sample, besides the EPR lines which come from the Cr^{3+} ions, the six Zeeman hyperfine splitting lines of Mn^{2+} (I = 5/2, where I is the nuclear spin) were observed around 335 mT, see Fig. 2. The EPR peak-to-peak linewidth, ΔH_{p-p}, was estimated to be 1.98 mT, and the Lande's factor $g \cong 2.05$. We believe that the origin of the unrecognized K-line (15547 cm^{-1}) in Ref. 1 is from the Mn^{2+} ($^4T_1 \rightarrow {}^6A_1$) emission.[3]

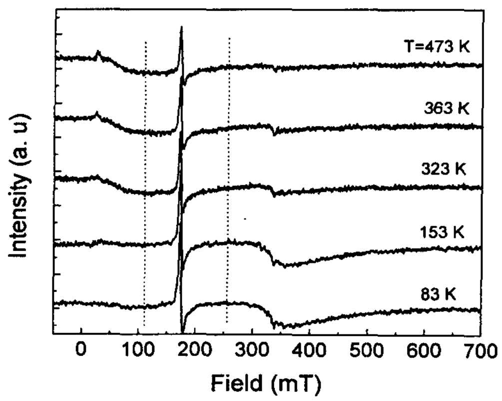

Fig. 1 EPR spectra of $MgAl_2O_4:Cr^{3+}$ spinel at selected temperatures.

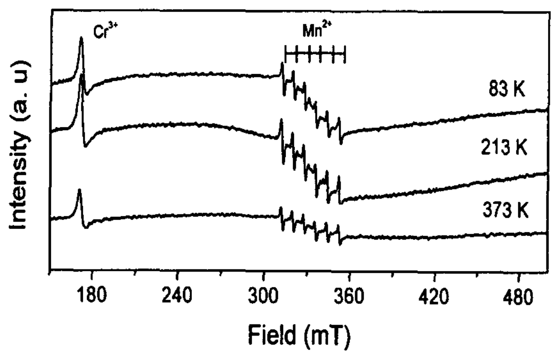

Fig. 2 EPR spectra of $MgAl_2O_4:Cr^{3+},Mn^{2+}$ spinel at selected temperatures.

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[3]P. Omling, B. K. Meyer, Phys. Rev. B, **44**, 5518 (1991).