Magnetic Field Induced Phase Transition in Mn3O4

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Mn3O4 crystallizes in the spinel-type structure where Mn2+ and Mn3+ ions occupy the tetrahedrally coordinated A sites and the octahedrally B sites, respectively. The Mn3+ (3d4, S=2) is in the twofold degenerated Eg state and thus Jahn-Teller active although Mn2+ (3d5, S=5/2) is inactive. Structural phase transition to elongated tetragonal structure via the Jahn-Teller effect occurs at Ts=1443 K to lift the Eg orbital degeneracy. The distortion c/a in the cubic setting approaches 1.15 at room temperature. Successive magnetic phase transitions occur at 42.5K, 40K, and 34K [1-3]. In the high temperature phase (42.5K>T>40K), Mn2+ spins align along [110] axis and [110] components of Mn3+ spin align antiparallel to Mn2+ spins. The [001] components of Mn3+ spin are arranged antiferromagnetic. The canted ferromagnetic structure is so-called YK structure. In the intermediated phase (40K>T>34K), magnetic periodicity along [110] axis becomes incommensurate. In the low temperature phase (34K>T), the [001] components of Mn3+ spin are rearranged and the magnetic periodicity consequently becomes twofold with propagation vector (1/2 1/2 0), which is so-called cell-doubling structure.

Recently we succeeded to grow a high-quality single crystal of Mn3O4 by floating zone technique, and thus, we clearly found a magnetic-field-induced phase transition in low field region (H<1T). In order to clarify mechanism of the transition in microscopic view, we have performed a neutron diffraction measurement by using PONTA installed 5G. Figure 1 shows magnetic-field change of several magnetic reflections. (2 0 0) and (3/2 1/2 0) reflections suddenly decrease and (0 2 0) reflection increases at around 0.3T. This result suggests that the cell-doubling structure changes to YK-type structure by applying a magnetic field.

References
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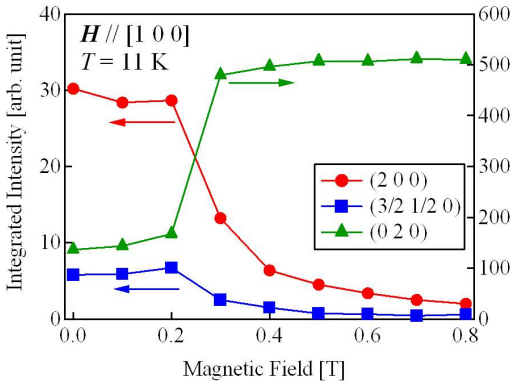

Fig. 1. Magnetic-field dependence of magnetic reflections (200), (3/2 1/2 0), and (020).