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Dy incommensurate magnetic order in DyFeO3 single crystal

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In recent years, RFeO3 systems have gained significant interest because of antiferromagnetic ordering correlation with next-generation high-density and high-speed magnonics applications [1, 2]. DyFeO3 is the first orthoferrite among the RFeO3 family to possess an incommensurate magnetic order of the rare earth sublattice under zero field conditions [3]. In DyFeO3 crystal system, there exist two magnetically ordered sublattices formed by rare earth Dy3+ ions and by Fe3+ ions. The magnetic transition temperature for ordering the Fe sublattice in Γ4 (GxAyFz) state is at TN1 ~ 650 K and for ordering Dy sublattice it is TN2 ~ 4 K. The Fe3+ magnetic order transform from Γ4 (GxAyFz) to Γ1 (AxGyCz) state at TSR ~ 73 K which is called as the spin reorientation transition. We report here the unusual incommensurate (IC) phase in the single crystalline DyFeO3 using our measurement at inelastic neutron scattering instrument (IN12, ILL) operated with zero energy transfer mode. Based on these measurements, higher harmonics (up to 7th order) of (001) magnetic peak corresponding to Dy order has been observed below 4 K. Similar higher order harmonics have been observed for Tb magnetic order in TbFeO3 single crystal with application of magnetic field parallel to c-axis [4]. Dy orders in incommensurate magnetic structure with k = [0, 0, L] where, L is the modulation length of IC phase. The modulation length L changes as a function of temperature over the 1 to 4 K with L = 0.0188 (1) at 2 K. Ritter et al. has reported the L = 0.028 at 2 K for the same compound in polycrystalline form [3]. The incommensurate periodicity of this IC phase is found to be approximately 53 units cells or ~ 405 Å in our study. Based on our analysis of neutron measurement, we conclude the co-existence of commensurate and IC phases of Dy ordering below 4 K.

FIG 1 : The scan measured at 3.66 K with various harmonics (+k, +3k, +5k, and +7k) reflection labeled accordingly.
FIG 2 : The variation of modulation length corresponding to Dy order as a function of temperature.

Reference :
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[4] S. Artyukhin et al., N. Mat. 11, 694-699 (2012)

Hauptautor: BHOSALE, Dnyaneshwar (Jülich Centre for Neutron Science JCNS at MLZ, Forschungszentrum Jülich)

Co-Autoren: Dr. FABRYKIEWICZ, Piotr; STEKIEL, Michal; SCHNEIDEWIND, Astrid; MAVEN, Martin; BHOSALE, Dnyaneshwar

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