Studies of Crystal Structure and Spin State in Diluted Triangular Spin Tube $KCr_{1-x}Al_xF_4$

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Non-magnetic impurity substitution in triangular spin tubes is expected to be competition between geometrical spin frustration in each triangular plane and impurity-induced antiferromagnetic long-range order. In equilateral triangle spin tubes composed of $CsCr_{1-x}Al_xF_4$ ($x = 0{\sim}0.06$), we found that no anomaly that indicates an antiferromagnetic long-range order appeared because geometrical spin frustration in the equilateral triangular plane is robust. In this study, we performed X-ray diffraction and magnetic susceptibility experiments on non-equilateral triangular spin tubes composed of α-$KCr_{1-x}Al_xF_4$ ($x = 0{\sim}0.10$). In α-$KCrF_4$, successive antiferromagnetic long-range order occurred at $T_{N1} = 2.5(1)$ K and $T_{N2} = 4.0(1)$ K, because geometrical spin frustration collapsed in each non-equilateral triangle. As a result, the values of spin-flop transition field drastically decreases with increasing x. This is probably due to the close correlation between the spin structure in the antiferromagnetic ordered state and the crystal structure as theoretically predicted by Nénert and Palstra, i.e., a magnetoelectric linear effect in which a magnetic field in an antiferromagnetic ordered state induces electrical polarization.[1] Thus we carefully verified the crystal structure for $x = 0{\sim}0.10$.

[1]G. Nénert and T. T. M. Palstra, J. Phys.: Condens. Matter **19**, 406213 (2007).