μSR study of an insulator near high-T_c honeycomb lattice superconductors

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A high-T_c layered superconductor, $Li_{0.48}(THF)_yHfNCl$ (T_c=25.5 K), was discovered by Yamanaka group in 1998[1]. The crystal structure has double honeycomb lattice of $[HfN]_2$[2]. The crystal structures of a series of double honeycomb lattice superconductors have been studied by our neutron diffraction experiments. The band structure is calculated by using LAPW+LDA[3]. Electrons are doped by alkali metal intercalation at K point in the bottom of conduction bands. The density of states $N(0)$ in 2-dimensional system is inversely propotional to the estimated transfer integral t_{dd} or band width W. If the $N(0)$ is the only variable parameter in the material like alkali doped fullerene superconductors, T_c varies as a function of the transfer integral t_{dd} estimated from the obtained crystal parameters based on Harrison values[4]. We found that the same honeycomb lattice material $Li_{0.16}YOCl$ was an insulator with small t_{dd}. In additon, this material shows spin glass like magnetism at H=100 Oe, although this sample includes non-magnetic impurity phases of LiCl and Y_2O_3. This magnetic behavior is not expected for a material with non-magnetic elements, although spin fluctuation senarios are theoretically discussed[5,6]. In addition, alkali fullerenes such as bcc Cs_3C_{60} exhibit antiferromagnetism as the Mott-Hubbard inslating state[7].

According to our zero-field μSR study under magnetic field, no explicit magnetic order has been observed for the $Li_{0.16}YOCl$ down to T= 2.5 K as shown in Fig. 1. The time dependent relaxation is also measured under magnetic fields. The μ^+ asymmetry is recovered by increasing an applied field. From the analysis of the decoupling curve of the asymmetry versus field, we found the relaxation rate can be represented by an $H^{-0.3}$ dependence in the range from 70 G to 3950 G as shown in Fig. 2. This behaviour is similar to that observed in the solitons of polyacetylene[8]. The exponent may suggest a correlation to the spin diffusion dimension in the $[YO]_2$ honeycomb lattice.

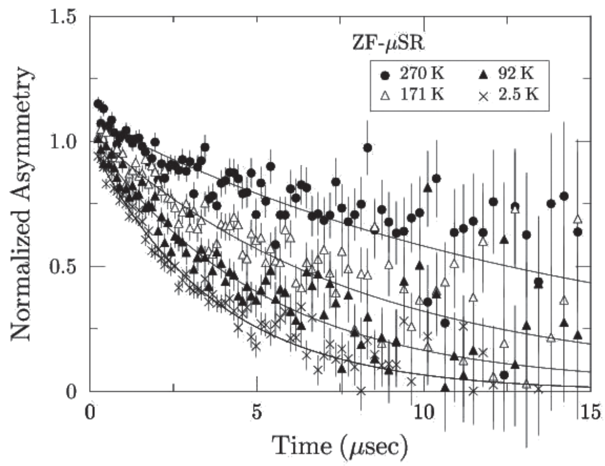

Fig. 1. The time spectra of decay positron asymmetry at various temperatures for $Li_{0.16}YOCl$.

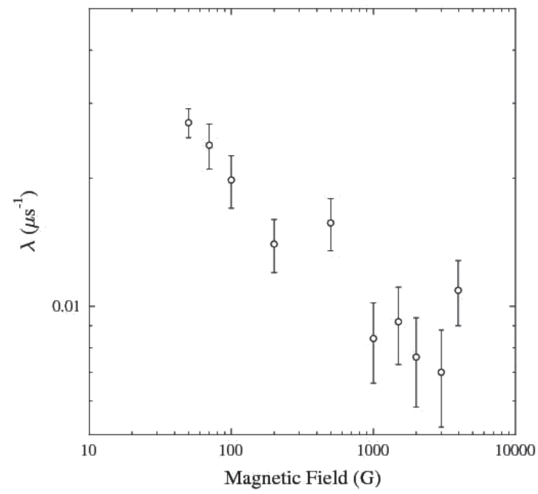

Fig. 2. Observed relaxation rates as a function of magnetic field for $Li_{0.16}YOCl$ at T=2.5 K.

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