Bond-randomness effect on the quantum spin system $Tl_{1-x}K_xCuCl_3$ probed by muon-spin-relaxation method

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The bond-randomness effect on the singlet ground state has been reported in the mixed system $Tl_{1-x}K_xCuCl_3$ [1,2]. In zero field (ZF), the ground state has no gap (magnetic) in the mixed system, although both the parent materials have finite excitation gaps (nonmagnetic). Shindo *et al.* carried out specific heat measurements in magnetic fields, and discussed the obtained phase diagram in connection with the appearance of a new phase, the Bose glass phase, in lower magnetic fields at $T = 0$. We observed the slight increase and the saturation of the muon spin relaxation rate λ in $Tl_{1-x}K_xCuCl_3$ with $x = 0.20$, and this result suggests the existence of the Bose glass phase [3]. Recently, ZF-μSR measurements for $x = 0.44$ were carried out, and the divergent increase of λ was observed, which suggests the critical slowing down of the frequency of the Cu-3d spin fluctuations toward a spin frozen state [4]. However, it is not yet known whether or not another ground state apart from the Bose-glass phase and the gapped state, for example, an ordered state, really appears when the randomness is enhanced with increasing the concentration of x in the system. In this study, in order to to investigate the ground state in highly random system and possibility of the existence of an ordered state, ZF- and LF-field μSR measurements were carried out in single crystals $Tl_{1-x}K_xCuCl_3$ with $x = 0.58$ at the Swiss Muon Source (SμS), Paul Scherrer Institut (PSI), Villigen, Switzerland.

ZF-μSR results reveals that the rapid increase of λ with decreasing temperature and that the saturation of λ below 0.5 K, and the absolute value of λ is three times larger than that in the case of $x = 0.44$. From the LF-μSR measurements, the dynamical fluctuation, which can not be decoupled upto 4000 gauss, remains at 20 mK. These results suggest that there is a quite possibility of the existence of an ordered phase in a neighbouring concentration of x around 0.58.

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