


(※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。)

 <b>MLF Experimental Report</b>	提出日 Date of Report 2011. 6. 30
課題番号 Project No. 2010A0078 実験課題名 Title of experiment Effects of nonmagnetic, magnetic and electrostatic impurities on the Cu-spin correlation and superconductivity in high- $T_c$ cuprates 実験責任者名 Name of principal investigator Tadashi Adachi 所属 Affiliation Department of Applied Physics, Graduate School of Engineering, Tohoku University	装置責任者 Name of responsible person Yasuhiro Miyake 装置名 Name of Instrument/(BL No.) D1 実施日 Date of Experiment 2010. 11. 16-19

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)  
 Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.  La-based high- $T_c$ superconducting cuprates $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}(\text{Zn,Ni,Fe,Ga})_y\text{O}_4$ with $x = 0.08 - 0.11$ and $y = 0 - 0.03$ Ceramic samples
---

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。) Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.  Zero-field $\mu\text{SR}$ measurements have been performed at temperatures between $\sim 3$ K and 20 K in $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}(\text{Zn,Ni,Fe,Ga})_y\text{O}_4$ with $x = 0.08 - 0.11$ and $y = 0 - 0.03$ . Samples for measurements used in the double-pulsed and single-pulsed mode are listed below.  For single-pulsed mode: Zn: $x = 0.08$ ; $y = 0.01, 0.03$ Ni: $x = 0.09$ ; $y = 0.01$ Fe: $x = 0.085$ ; $y = 0.005$ , $x = 0.09$ ; $y = 0.01$ , $x = 0.11$ ; $y = 0.03$ Ga: $x = 0.09$ ; $y = 0.01$ , $x = 0.11$ ; $y = 0.03$  For double-pulsed mode: Zn: $x = 0.08$ ; $y = 0.01$ Fe: $x = 0.085$ ; $y = 0.005$ , $x = 0.09$ ; $y = 0.01$ , $x = 0.11$ ; $y = 0.03$ Ga: $x = 0.09$ ; $y = 0.01$
--

## 2. 実験方法及び結果(つづき) Experimental method and results (continued)

Figure 1 shows the zero-field (ZF)  $\mu$ SR time spectra measured in the double-pulsed mode of the 0.5 % Fe-substituted  $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Fe}_y\text{O}_4$  with  $x = 0.085$  and  $y = 0.005$ . At high temperatures of 17.8 K, the spectrum shows Gaussian-like slow depolarization due to randomly oriented nuclear spins. With decreasing temperature, the spectrum changes from Gaussian-type to exponential-type and a muon-spin precession is observed below 3.8 K, indicating the formation of a long-range magnetic order of Cu spins through 0.5 % Fe substitution.

In order to investigate the precession spectra in detail, we have performed ZF- $\mu$ SR in the single-pulsed mode by using the beam slicer. For 1 % substitution of Zn, Ni, Fe, Ga, all the samples show the muon-spin precession at  $\sim 3$  K. However, due to an instrumental problem, the attained lowest temperature is different from each sample, preventing us from comparing explicitly the effects of nonmagnetic, magnetic and electrostatic impurities on the Cu-spin correlation by focusing on an internal magnetic field, magnetic volume fraction and damping rate. In order to obtain detailed information on them, improvements of the instrument at D1 are desired.

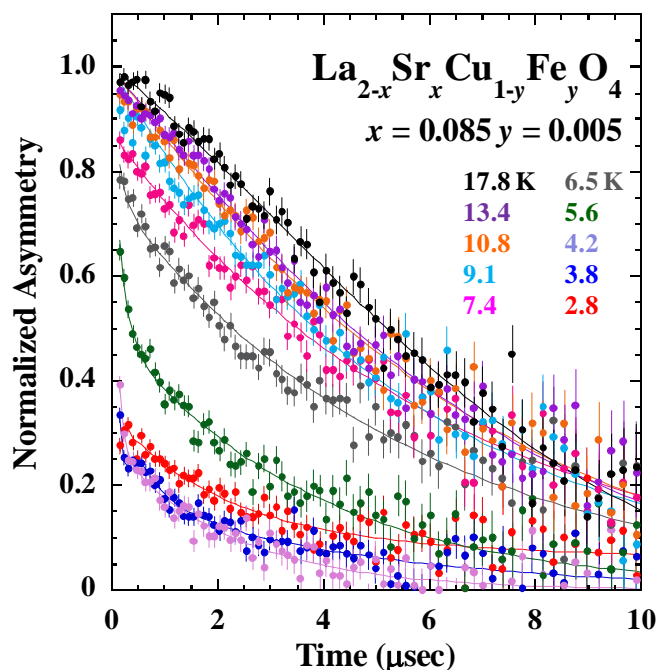


Fig. 1. Zero-field  $\mu$ SR time spectra of the 0.5 % Fe-substituted  $\text{La}_{2-x}\text{Sr}_x\text{Cu}_{1-y}\text{Fe}_y\text{O}_4$  with  $x = 0.085$  and  $y = 0.005$ .