<table>
<thead>
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<th>Title</th>
<th>Magnetic phase diagrams of NCCO and PLCCO investigated by means of μSR measurements / Preparation of electron-doped superconductor by electrochemical reduction (SOLID STATE CHEMISTRY - Quantum Spin Fluids)</th>
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<tr>
<td>Author(s)</td>
<td>YAMADA, Kazuyoshi; MIBU, Ko; IKEDA, Yasunori</td>
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Kyoto University
Solid State Chemistry - Quantum Spin Fluids -

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Scope of Research

Quantum spin oxide system such as high-$T_c$ superconducting cuprates, La$_{2-x}$(Ba,Sr)$_x$CuO$_4$, Nd$_{2-x}$Ce$_x$CuO$_4$, and Pr$_{1.4}$LaCe$_{0.6}$CuO$_4$ are synthesized in the form of single crystals using traveling-solvent-floating-zone method. Detailed equilibrium phase diagram of Bi cuprate systems is investigated. Main subjects and techniques are: mechanism of high-$T_c$ superconductivity: origin of quantum phase separation in strongly correlated electron systems: spin excitations in quantum spin systems: interplay between spin and charge flow in doped spin systems: neutron scattering by using triple-axis as well as time-of-flight techniques.

Research Activities (Year 2001)

Presentations


Grants


Fujita M, Study of High-$T_c$ superconductivity mechanism in the electron-doped cuprates, Grant-in-Aid for Encouragement of Yong Scientists, 1 April 2001 - 31 March 2003.
Magnetic phase diagrams of NCCO and PLCCO investigated by means of μSR measurements

Magnetic phase diagrams of electron-doped high-temperature superconducting cuprates Nd$_{2-x}$Ce$_x$CuO$_{4-\delta}$ (NCCO) and Pr$_{1-x}$LaCe$_x$CuO$_{4-\delta}$ (PLCCO) have been studied by means of muon spin relaxation and rotation (μSR) measurements. Two characteristic temperatures $T_{N1}$ and $T_{N2}$ are defined in the zero-field μSR (ZF-μSR) measurements for both NCCO and PLCCO. Below $T=0$, which approximately corresponds to the previously reported Néel temperature, an exponential type muon spin relaxation firstly appears in the time spectra and upon cooling below around $T_{N2}$ another faster component of relaxation or muon spin rotation is observed similarly. Although critical concentration for the superconductivity is different between the two systems, antiferromagnetic (AF) phase commonly contacts with the superconducting phase. In contrast to the hole-doped superconductivity the electron-doped superconductivity is more drastically terminated by the AF order.

Preparation of electron-doped superconductor by electrochemical reduction

Electrochemical reduction processes were performed using the opposite chemical reactions to the electrochemical oxidation. As shown in the right figure, we succeeded in preparing superconducting Nd$_{1.85}$Ce$_{0.15}$CuO$_4$ samples from the insulating as-grown samples using electrochemical reduction, though the obtained $T_c \sim 15$K is lower than that of the heat-treated sample, $T_c \sim 24$K. In this figure, we show the dependence on $V_{pot}$ of magnetic susceptibilities for samples treated with different $V_{pot}$ values, $V_{pot} = V_{count} - V_{ref}$ between the counter and reference electrodes in the range of 0 ~ 1V as shown in the inset. We, furthermore, performed the electrochemical reduction under various conditions as functions of $V_{pot}$ and treating time. However, the maximal diamagnetism at 5K and $T_c$ were nearly the same. One of the reasons for such small diamagnetic signal and low $T_c$ compared to heat-treated samples may be due to a small mobility of oxygen atoms inside the sample, which causes the inhomogeneous distribution of oxygen atoms.