Electrical Transport Characteristics in Layered c-axis $La_{2-x}Sr_xCuO_4$ (LSCO) Single Crystals

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We fabricated c-axis micro-bridges of $La_{2-x}Sr_xCuO_4$ (LSCO) single crystals by focused-ion-beam (FIB) etching method. Small LSCO pieces of rectangular form were fabricated by cutting and grinding of the single crystals of underdoped (x=0.09, $T_C \approx 20K$) LSCO, The sizes of these LSCO pieces were typically about 40×40 μm^2 in area for the ab-plane and 150 μm in length along the c-axis of which corresponds to the half wavelength of Josepshon plasma frequency of LSCO (x=0.09). The single crystal fixed on Au/MgO substrates by annealing in an oxygen atmosphere at 450 degrees for 30 min. The width of LSCO single crystals between electrodes was decreased to 20×40 μm^2 in ab-plane by using the FIB etching method. Here we observed two types of current (I)-voltage (V) characteristics of the micro-bridges of the LSCO stacks. First type of I-V characteristics exhibited a large hysteresis with a voltage jump of the order of several voltages and no multiple branch structures. The other type exhibited several branch structures with voltage jumps of several tens mV in the range from 2 K to 5 K with temperature dependence. When the temperature is changed from 5 K to 2 K, the I-V curves around zero bias regions of critical current and the next branch split into a few of small voltage jumps with the intervals of several mV in the range from 0.1 mV and 2.0 mV at 3 K. Transport characteristics related to strongly coupled layered structures in c-axis LSCO single crystals will be discussed in this report.

keywords : $La_{2-x}Sr_xCuO_4$ (LSCO), focused-ion-beam (FIB), multiple branch structures, c-axis single crystals