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CONDUCTIVITY FLUCTUATIONS AND CRITICAL PARAMETERS OF $CaLaBaCu_{3-x}Ga_xO_{7-\delta}$ SUPERCONDUCTING MATERIAL

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Systematic conductivity fluctuation analyses on the $CaLaBaCu_{3-x}Ga_xO_{7-\delta}$ (x=0.06, 0.12, 0.18, 0.24, 0.30 and 0.36) system are reported. Samples were prepared by the standard solid state reaction recipe. Crystallographic tetragonal phase and lattice parameters were determined by x-ray diffraction experiments. Resistivity measurements were performed by using an AC low-frequency technique. Fluctuation analyses near the critical temperature T_c were made through the application of the Kouvel-Fisher method, e.g., the logarithmic temperature derivative of the conductivity excess. Close to T_c, results reveal the occurrence of three- and two-dimensional Gaussian fluctuation regimes, which are analyzed by the Aslamazov-Larkin theory. By the utilization of the Ginzburg-Landau theory, we experimentally determined the Ginzburg number. From the respective results, we calculated critical magnetic fields, critical current density and jump in the specific heat for all Ga concentrations. Closer to T_c, a genuinely critical regime was identified. Scaling of our results permits to establish that the dynamical of fluctuation system has the universality class described by the 3D-XY model. We performed conductivity fluctuation analysis in the $CaLaBaCu_{3-x}Ga_xO_{7-\delta}$ superconducting material. Close and above T_c, the conductivity fluctuation analysis reveal the occurrence of two fluctuation regimes characterized by the critical exponents $\lambda_{3D}=0.54$ and $\lambda_{2D}=0.95$, respectively. These regions were interpreted as corresponding to 3D and 2D Gaussian regimes, respectively. Another intermediated regime was identified, which is related with fluctuations develop in spaces with fractal topology between three and two dimensionalities. Critical magnetic fields and critical current density were indirectly calculated from the Ginzburg number.

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