Coincident disappearance of the stripe order and the superconductivity in $La_{2-x}Sr_xCu_{1-y}M_yO_4$ (M = Fe, Al)

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The so-called stripe correlation of spins and holes has been studied intensively in order to clarify its relationship with the appearance of the high-T_c cuprate superconductivity. Impurity substitution is one of crucial ways to study the stripe correlation, because substituted impurities tend to slow down the spin fluctuations leading to formation of the static stripe order. Here we show the results of muon-spin-relaxation (μSR) and magnetic susceptibility measurements for magnetic Fe^{3+}- and nonmagnetic Al^{3+}-substituted $La_{2-x}Sr_xCu_{1-y}M_yO_4$ (M = Fe, Al).

It has been found that the 5% Fe substitution induces double magnetic ordering in the overdoped regime of $La_{2-x}Sr_xCu_{1-y}Fe_yO_4$ (LSCFO). While the magnetic order at higher temperatures is a spin glass state of Fe^{3+} spins due to the Ruderman-Kittel-Kasuya-Yosida interaction, the magnetic order at lower temperatures is the stripe order. Furthermore, the stripe order develops both in the underdoped and overdoped regimes and disappears at the hole concentration per Cu, p, of 0.28 where the superconductivity disappears in pristine $La_{2-x}Sr_xCuO_4$. The 3% Al substitution has also been found to induce the static stripe order in a wide range of p in $La_{2-x}Sr_xCu_{1-y}Al_yO_4$. The magnetic ordering temperature decreases with hole doping, and disappears at $p \sim 0.28$. Therefore, it has been concluded that, regardless of the type of impurities, the development of the stripe correlation is observed up to $p \sim 0.28$, suggesting an intimate relation of the stripe correlation with the appearance of the high-T_c superconductivity.

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