Searching for superconductivity in $SrCuO_2$ heterostructures

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The discovery of high-T_c superconductivity has led to the intensive study of the infinite-layer parent compounds of the superconducting cuprates. These compounds, whilst insulating when grown in the purely infinite-layer phase ($ACuO_2$), can be made superconducting via electron or hole doping, through chemical substitution or defect-layer formation.

The research activity focused on these materials has intensified with progress in thin-film deposition techniques, which allowed for the straightforward stabilization of the infinite-layer phases. Consequentially, this progress has led to a plethora of discoveries, including superconductivity in artificially layered cuprates [1], interface superconductivity between the infinite layer $CaCuO_2$ and the perovskite $SrTiO_3$ [2, 3], and complete structural reconstructions led by the polar nature of the planes in $SrCuO_2$ [4, 5]. The rich physics that can be explored in an otherwise simple structure can therefore be utilized for material control through heterostructure engineering [6].

Here, we present results on $SrCuO_{2+\delta}$ thin films grown by pulsed laser deposition in a highly oxidizing atmosphere. Using a combination of x-ray diffraction, x-ray absorption spectroscopy and x-ray photoelectron spectroscopy we find that highly oxidizing growth conditions can be employed to stabilize a structure with high oxygen content, where additional oxygens are incorporated in the SrO_δ planes ($SrCuO_{2+\delta}$). Our measurements indicate that the valence of Cu in the structure increases, with additional oxygen atoms leading to hole doping. Therefore, controlling the oxygen content in the structure can lead to precise control of the doping in these systems and may lead to superconductivity.

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