Doping influence on as-grown superconducting $Pr_{2-x}Ce_xCuO_4$

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Commonly, $Nd_{2-x}Ce_xCuO_4$ cuprates, which presumably contain impurity oxygen ions at apical sites, show a wide antiferromagnetic region (x = 0.00-0.12). However, depth-resolved muon spin rotation measurements by K. M. Kojima *et al.* on superconducting T'-$La_{1.9}Y_{0.1}CuO_4$ (x = 0.00) thin films have revealed the absence of any long-range antiferromagnetic order [1]. Synthesis conditions as well as electronic correlations have been extensively investigated for both optimally- and under-doped $RE_{2-x}Ce_xCuO_4$. We have recently demonstrated that superconductivity can be induced to as-grown Pr_2CuO_4 by a stringent control of growth conditions [2]. In contrast, a process commonly referred to "post-synthesis annealing" is an established route for the induction of superconductivity and elimination of defects in $RE_{2-x}Ce_xCuO_4$. A much less investigated regime are over-doped $RE_{2-x}Ce_xCuO_4$. Here, we aim at a detailed investigation of synthesis conditions using molecular beam epitaxy for high quality over doped $Pr_{2-x}Ce_xCuO_4$ ($x \geq 0.15$). It is worth being mentioned that the Ce substitution in $Pr_{2-x}Ce_xCuO_4$ reduces thermodynamic constraints for the induction of superconductivity, and hence, even $Pr_{2-x}Ce_xCuO_4$ films grown in a relaxed mode on $SrTiO_3$ substrates show superconductivity in their as-grown state. This is in contrast to as-grown superconducting Pr_2CuO_4, where a coherent growth mode on $GdScO_3$ substrates plays a crucial role [2]. Doping enhances the density of states at Fermi level with an increase of defect concentration, and metallic conduction is enhanced, *i.e.*, decrease of resistivity with increase of residual resistivity ratio.

[1] K. M. Kojima et al., Phys. Rev. B 89, 180508(R) (2014).
[2] Y. Krockenberger et al., Appl. Phys. Express 8, 053101 (2015).

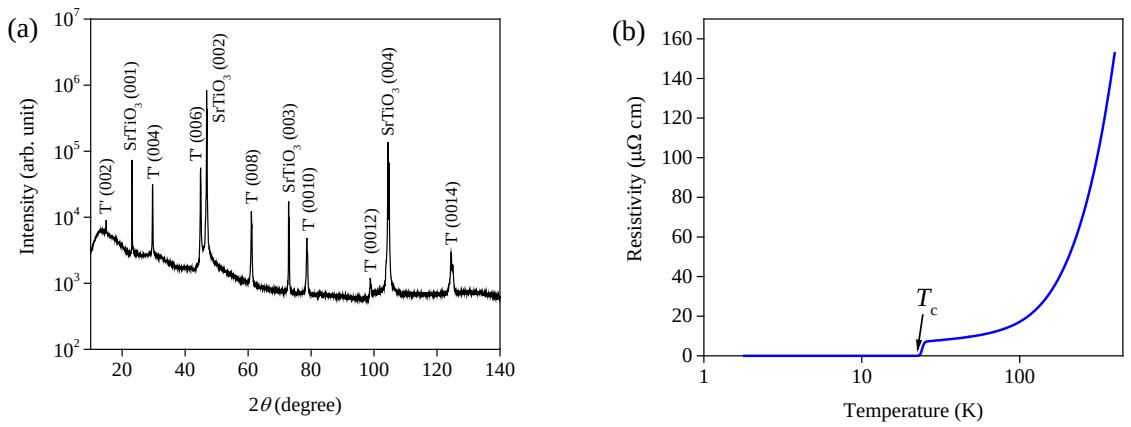

Figure 1. (a) XRD-pattern and (b) temperature dependence of resistivity of as-grown T'-$Pr_{1.85}Ce_{0.15}CuO_4$ thin films on (001) $SrTiO_3$ substrates.