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Effects of Epitaxial Strain on Doping in $YBa_2Cu_3O_{7-x}$/$PrBa_2Cu_3O_7$ Superlattices

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EFFECTS OF EPITAXIAL STRAIN ON DOPING IN $YBa_2Cu_3O_{7-x}/PrBa_2Cu_3O_7$ SUPERLATTICES

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ABSTRACT

The critical temperature of ultrathin (1-5 unit cells) $YBa_2Cu_3O_{7-x}$ layers is known to decrease when the thickness is reduced. Although several explanations have been proposed for this reduction (dimensionality, proximity effect, strain, charge transfer, etc.), the exact mechanism remains unknown. In this communication we examine this problem in high quality [$YBa_2Cu_3O_{7-x}$(YBCO) $_N$ / $PrBa_2Cu_3O_7$ $(PBCO)_M$] 1000Å superlattices, with N ranging between 1 and 12 unit cells and M=5 unit cells, grown by high oxygen pressure sputtering [1]. Intracell structure has been analyzed by x ray diffraction (XRD) and transmission electron microscopy (TEM) [2]. We have found significant epitaxial strain for YBCO thickness below 4 unit cells. To investigate possible effects of the intracell strains in doping, we have systematically changed the doping level adjusting the oxygen content during sample cool down. Transport measurements and high spatial resolution electron energy loss spectroscopy (EELS) in a scanning transmission electron microscope conclusively show that the strained layers are underdoped, probably as a result of a hindered charge transfer arising from a reduced Ba-CuO chains distance in the strained layers.

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