We present our latest results obtained by Angle Resolved Photoemission Spectroscopy (ARPES) and x-ray diffraction to study the effect of strain on 8 unit cell (≈105Å) thin epitaxial La$_{2-x}$Sr$_x$CuO$_{4-δ}$ (LSCO) films grown in situ by pulsed laser deposition on (001)-SrLaAlO$_4$ single crystal substrates.

The band dispersion along the reciprocal space direction $Γ−X$ for optimally-doped ($x = 0.15$) samples under in-plane compressive strain shows a surprising crossing that occurs at $k_X ≈ 0.90$ $π/a$, below the Brillouin zone (BZ) boundary. For slightly under-doped samples ($x=0.10$), under the same uni-axial strain, the band reaches the Fermi level at almost the BZ boundary ($k_X ≈ π/a$). This first direct probing of the electronic structure on strained LSCO films, is in sharp contrast with the dispersion recently observed by ARPES on non-strained LSCO single crystals where, for the two above mentioned doping values, the authors observed a flat band lying well below the Fermi level at the saddle point position ($π/a,0$). Moreover, the observed evolution of the Fermi surface topology (from hole-like to electron-like) under in-plane compressive strain does not follow the existing predictions by band structure calculations. The critical temperature enhancement (from 38K to 44K) in our films despite the reduction of the DOS near $E_F$ poses an additional challenge to the emerging theories of high temperature superconductivity.