Beyond annealing: A revealing story of electron doped cuprate superconductors

YOSHIHARU KROCKENBERGER, MASAFUMI HORIO, HIDETOSHI IRIE, HIDEKI YAMAMOTO, NTT Basic Research Labs — High superconducting transition temperatures are a unique feature of cuprate superconductors. The standard phase diagram randomly combines cuprates with various Cu coordinations, e.g., octahedral vs. square-planar, thus violates electron-hole symmetry arguments. In contrast to hole-doped cuprates, the concept of doping dependency is disobeyed on the electron-doped side. Doping alone fails to induce superconductivity and a process commonly referred to as “annealing” is required. We have shown that an elaborate annealing process, i.e. 2-step annealing process, is capable to induce superconductivity into Pr$_{2-x}$Ce$_x$CuO$_4$ with $x$ as low as $x = 0.00$. Here we show that appropriate synthesis conditions allow for the growth of as-grown superconducting Pr$_2$CuO$_4$ and T'-La$_2$CuO$_4$ thin films by molecular beam epitaxy. We observe a hole-like Hall coefficient being linear up to high magnetic fields. Hence, high quality thin films of electron doped cuprate superconductors still show a positive Hall coefficient even at optimal doping level. Finally, the transition from a Mott insulator in T-La$_2$CuO$_4$ to a superconducting metal in T'-La$_2$CuO$_4$ at $x = 0.00$ is solely associated to the coordination of Cu.