STRUCTURAL CHANGES INDUCED BY FLASH IN A SINGLE CRYSTAL OF Pr_2CuO_4

Dmitry Reznik, University of Colorado-Boulder
dmitry.reznik@colorado.edu
Susmita Roy, University of Colorado-Boulder
Yu Zhang, University of Colorado-Boulder
Gang Cao, University of Colorado-Boulder
Syed I. A. Jalali, University of Colorado-Boulder
Rishi Raj, University of Colorado-Boulder
Zachary Morgan, Martin Greven, University of Minnesota
Feng Ye, Zachary Morgan, Oak Ridge National Lab

Key Words: copper oxide superconductors, neutron diffuse scattering

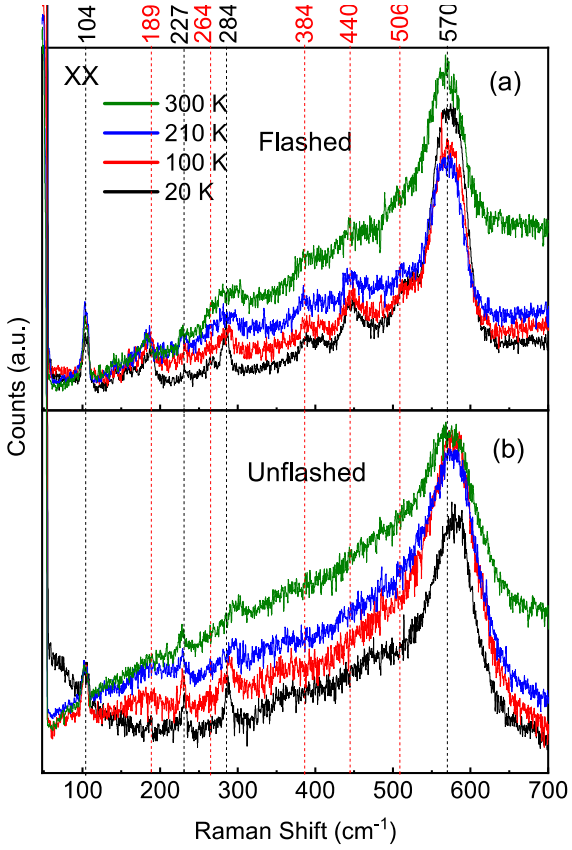

Figure 1 – Comparison of Raman spectra of unflashed a flashed single crystal of Pr_2CuO_4

We demonstrate a novel approach to the structural and electronic property modification of perovskites, focusing on Pr_2CuO_4, an undoped parent compound of a class of electron-doped copper oxide superconductors. Currents were passed parallel or perpendicular to the copper oxygen layers with the voltage ramped up until a rapid drop in the resistivity was achieved, a process referred to as ”Flash”. The current was then further increased tenfold in current-control mode. This state was quenched by immersion into liquid nitrogen (LN_2). Flash can drive many compounds into different atomic structures with new properties, whereas the quench freezes them into a long-lived state. Single-crystal neutron diffraction of as-grown and modified Pr_2CuO_4 revealed a $\sqrt{10}x\sqrt{10}$ superlattice due to oxygen vacancy order. The diffraction peak intensities of the superlattice of the modified sample were significantly enhanced relative to the pristine sample. Raman-active phonons in the modified sample were considerably sharper. Measurements of electrical resistivity, magnetization and two-magnon Raman scattering indicate that the modification affected only the Pr-O layers, but not the Cu-O planes. These results point to enhanced oxygen vacancy order in the modified samples well beyond what can be achieved without passing electrical current. Our work opens a new avenue toward electric field/quench control of structure and properties of layered perovskite oxides.

arXiv:2302.04385