Atomic scale electronic structure patterning in lightly hole-doped cuprates: 'Glassy' Electronic Nanodomains

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High temperature superconductivity (HTSC) appears in the insulating CuO_2 crystal planes of the cuprates, when the planar oxygen atoms are doped with holes. At low hole-densities, many other unprecedented electronic phenomena are also observed. The existence of a 'hidden' electronic phase in this lightly-doped 'pseudogap regime' has long been postulated. It would be the true 'parent phase' from which HTSC emerges.

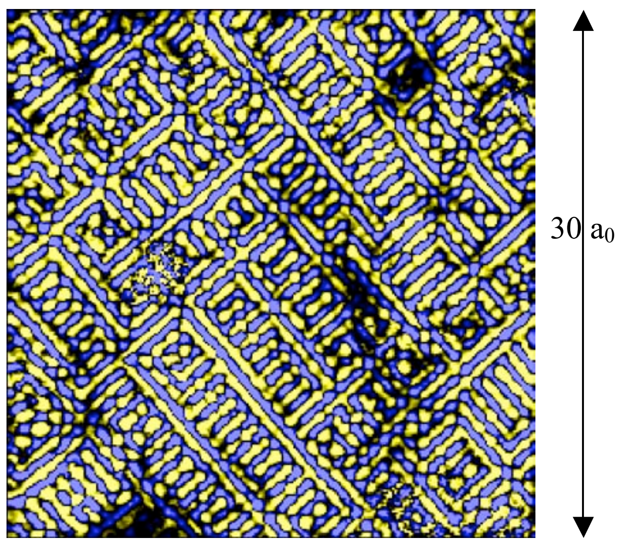

Fig. 1a False color image of spectral weight transfers on the planar oxygen atoms deduced from atomic-resolution tunneling asymmetry measurements in $Ca_{2-x}Na_xCuO_2Cl$.

We recently began the first STM studies within the ground state of the 'pseudogap regime'. [1] Our material, $Ca_{2-x}Na_xCuO_2Cl_2$ is among the simplest cuprate crystals - only one CuO_2 plane in the unit cell. The maze-like electronic structure we observe in the spectral weight shifts at oxygen atoms appears to be a 'spin/hole glass' with short range $4a_0X4a_0$ correlations. Embedded in this 'glass' are apparently self-organized electronic nano-regions of approximate dimensions ~$4a_0X16a_0$. We examine these structures with atomic resolution, distinguishing the electronic state on different oxygen sites, the source of breaking of rotational symmetry and the lack of long rang order. We discuss their relationship to the ubiquitous 'cluster glass' state observed by NMR, NQR, mSR, INS etc. Time permitting; I will describe our efforts to determine the universality[2] of this state and its relevance to the basic underlying mysteries of the cuprates.

[1] T. Hanaguri *et al* , ***Nature 403*** 1001 (2004)

[2] Y. Kohsaka et al, ***Submitted*** (2006).