



	Experiment title: Optimum inhomogeneity of local lattice distortions in La₂CuO_{4+y}	Experiment number: HE3798
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Report:

Here we use scanning X-ray microdiffraction (with a beam 300 nm in diameter) to show that for La₂CuO_{4+y}, the glue regions contain incommensurate modulated local lattice distortions, whose spatial extent is most pronounced for the best superconducting samples. For an underdoped single crystal with mobile oxygen interstitials in the spacer La₂O_{2+y} layers intercalated between the CuO₂ layers, the incommensurate modulated local lattice distortions form droplets anticorrelated with the ordered oxygen interstitials, and whose spatial extent is most pronounced for the best superconducting samples. In this simplest of high temperature superconductors, there are therefore not one, but two networks of ordered defects which can be tuned to achieve optimal superconductivity. For a given stoichiometry, the highest transition temperature is obtained when both the ordered oxygen and lattice defects form fractal patterns, as opposed to appearing in isolated spots. We speculate that the relationship between material complexity and superconducting transition temperature T_c is actually underpinned by a fundamental relation between T_c and the distribution of ordered defect networks supported by the materials [1].

[1] N. Poccia, A. Ricci, G. Campi, M. Fratini, A. Puri, D. Di Gioacchino, A. Marcelli, M. Reynolds, M. Burghammer, N. L. Saini, et al., "Optimum inhomogeneity of local lattice distortions in La₂CuO_{4+y}" Proceedings of the National Academy of Sciences 109, 15685 (2012), ISSN 1091-6490, URL <http://dx.doi.org/10.1073/pnas.1208492109>