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Atomic-resolution imaging of oxygen vacancy induced spin state superlattice in $\mathbf{La_{0.5}Sr_{0.5}CoO_{3-\delta}}$ J. GAZQUEZ, M. VARELA, S. J. PENNYCOOK, Oak Ridge Natl. Lab., W. LUO, M.P. OXLEY, M. PRANGE, M. PANTELIDES, Vanderbilt Univ., M.A. TORIJA, M. SHARMA, C. LEIGHTON, Univ. of Minnesota, OAK RIDGE NATL. LAB. TEAM, VANDERBILT UNIV. TEAM, UNIV. OF MINNESOTA COLLABORATION — Certain complex cobalt oxides with perovskite structure are known to exhibit ordered Co spin states. The O K edge in electron energy loss spectroscopy (EELS) is sensitive to the spin state of Co atoms, and is used here to image such spin state superlattice in $La_{0.5}Sr_{0.5}CoO_{3-\delta}$ (LSCO) thin films in real space with atomic resolution. First principles calculations predict that a spin state ordering made of alternating planes with Co in high and low spin states can be stabilized in strained LSCO films through the ordering of oxygen vacancies. EELS images confirm that Co is significantly reduced and those Co atoms in the oxygen deficient CoO plane are in the high spin state, while the Co atoms in the fully oxygenated plane are in the low spin state. Research at ORNL sponsored by the Division of Materials Sciences and Engineering of the US DoE. Work at UMN supported by NSF DMR and DoE BES. Work at Vanderbilt supported by DoE BES grant DE-FG02-09R46554.

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