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Oxygen vacancy ordering in transition-metal-oxide $LaCoO_3$ films[1]

NEVEN BISKUP, JUAN SALAFRANCA, Univ. Complutense, Spain, VIRAT MEHTA, Univ. California, Berkeley, YURI SUZUKI, Univ. California, Berkeley and LBNL, STEPHEN PENNYCOOK, Oak Ridge National Laboratory, SOKRATES PANTELIDES, Vanderbilt University, MARIA VARELA, Univ. Complutense, Spain — Oxygen vacancies in complex oxides affect the structure and the electronic and magnetic properties. Here we use atomically-resolved Z-contrast imaging, electron-energy-loss spectroscopy and densityfunctional calculations to demonstrate that ordered oxygen vacancies may act as the controlling degree of freedom for the structural, electronic, and magnetic properties of $LaCoO_3$ thin films. We find that epitaxial strain is released through the formation of O vacancy superlattices. The O vacancies donate excess electrons to the Co *d*-states, resulting in ferromagnetic ordering. The appearance of Peierls-like minigaps followed by strain relaxation triggers a nonlinear rupture of the energy bands, which explains the observed insulating behavior. We conclude that oxygen vacancy ordering constitutes a degree of freedom that can be used to engineer novel behavior in complex-oxide films.

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Maria Varela
Oak Ridge National Laboratory

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