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Strain-induced oxygen vacancies in ultrathin epitaxial $CaMnO_3$ films RAVINI CHANDRASENA, WEIBING YANG, QINGYU LEI, Department of Physics, Temple University, Philadelphia, PA, USA, MARIO DELGADO-JAIME, FRANK DE GROOT, Inorganic Chemistry Catalysis, Debye Institute for Nanomaterials Science, Utrecht University, Utrecht, The Netherlands, ELKE ARENHOLZ, Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA, USA, KEISUKE KOBAYASHI, Materials Sciences Research Center, Japan Atomic Energy Agency, Sayo, Japan, ULRICH ASCHAUER, NICOLA SPALDIN, Materials Theory, ETH Zurich, Zurich, Switzerland, XIAOXING XI, ALEXANDER GRAY, Department of Physics, Temple University, Philadelphia, PA, USA — Dynamic control of strain-induced ionic defects in transition-metal oxides is considered to be an exciting new avenue towards creating materials with novel electronic, magnetic and structural properties. Here we use atomic layer-by-layer laser molecular beam epitaxy to synthesize high-quality ultrathin single-crystalline $CaMnO_3$ films with systematically varying coherent tensile strain. We then utilize a combination of high-resolution soft x-ray absorption spectroscopy and bulk-sensitive hard x-ray photoemission spectroscopy in conjunction with first-principles theory and core-hole multiplet calculations to establish a direct link between the coherent in-plane strain and the oxygen-vacancy content. We show that the oxygen vacancies are highly mobile, which necessitates an in-situ-grown capping layer in order to preserve the original strain-induced oxygen-vacancy content. Our findings open the door for designing and controlling new ionically active properties in strongly-correlated transition-metal oxides.

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