

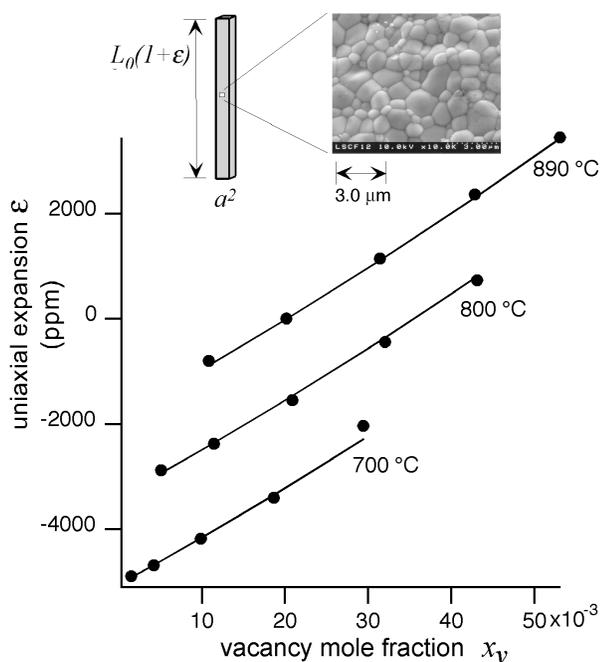
## Chemical Expansion in Mixed Conducting Perovskites

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In order to better understand thermal strain in electrochemical ceramics, we have measured the temperature and oxidation-state dependence of lattice volume in  $\text{La}_{1-x}\text{Sr}_x\text{CoO}_{3-\delta}$  ( $x = 0.2, 0.4, \text{ and } 0.7$ ), and  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Co}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  (LSCF) using high-temperature, controlled atmosphere dilatometry. We find that large values in apparent thermal expansion coefficient at high temperature ( $>50 \text{ ppm}/^\circ\text{C}$ ) are caused by changes in oxygen content (not by increases in thermal expansivity). We describe expansion in these materials using an improved thermodynamic formalism that incorporates a new physical property, the *Chemical Expansivity*.

Materials with varying Sr and Fe content ( $x$  and  $y$ ) have similar chemical expansivity at high oxygen vacancy concentration. However, materials with metallic electronic structure appear to have nonlinear chemical expansion, with much smaller expansion near  $\delta=0$ . We discuss possible reasons for this nonlinearity, as well as the use of expansion-relaxation experiments to measure transport and kinetic properties.



Equilibrium Thermal and Chemical Expansion in LSCF.