Atomic scale characterization of vacancy segregation and ordering in oxides

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The combination of Z-contrast imaging and electron energy loss spectroscopy (EELS) in the scanning transmission electron microscope (STEM) provides an unparalleled means to characterize the atomic and electronic structure at interfaces and extended defects. For oxide systems, a stable heating stage (at temperatures up to 500^{o}C) in the high-vacuum conditions of the microscope can be used to induce vacancies in the structure that can then be observed directly with these methods. By inducing vacancies in the sample in-situ, the dynamics of vacancy segregation and its subsequent effect on ionic and electronic conductivity at interfaces can be understood. Furthermore, the conditions in the microscope are so favorable for vacancy formation that energetically favorable ordered structures and structural decomposition can also be seen. Current work is aimed at extending the ability to observe atomic scale structural changes by incorporating an in-situ gas stage into the high-resolution microscope. This stage will allow oxidation as well as reduction effects to be studied at atomic resolution.