Enhanced oxygen exchange of perovskite oxide surfaces through strain-driven chemical stabilization

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Abstract
Surface cation segregation and phase separation, strontium in particular, has been suggested to be the key reason behind the chemical instability of perovskite oxide surfaces and the corresponding performance degradation of solid oxide electrochemical cell electrodes. However, there is no well-established solution for effectively suppressing Sr-related surface instabilities. Here, we control the degree of Sr-excess at the surface of SrTi$_{0.5}$Fe$_{0.5}$O$_{3-\delta}$ thin films, a model mixed conducting perovskite O$_2$-electrode, through lattice strain, which significantly improves the electrode surface reactivity. Combined theoretical and experimental analyses show that Sr cations are intrinsically under a compressive state in the SrTi$_{0.5}$Fe$_{0.5}$O$_{3-\delta}$ lattice and that the Sr-O bonds are weakened by the local pressure around the Sr cation, which is the key origin of surface Sr enrichment. Based on these findings, we successfully demonstrate that when a large-sized isovalent dopant is added, Sr-excess can be remarkably alleviated, improving the chemical stability of the resulting perovskite O$_2$-electrodes.

Biography
WooChul Jung received his PhD degree from the Department of Materials Science and Engineering at Massachusetts Institute of Technology (MIT) and served as postdoctoral fellow in the Department of Materials Science at California Institute of Technology (Caltech). He has been with the Department of Materials Science and Engineering at Korea Advanced Institute of Science and Technology (KAIST) as Assistant Professor since 2013. The main goal of his research activities is to understand the reactions that occur at the interfaces between ionic solids (oxides in particular) and gases and thereby to improve the reaction kinetics for applications in chemical and electrochemical catalysis, such as solid oxide fuel cells, electrolyzers, and hydrocarbon reformers. He has been actively developing oxide model structures with well-defined interface geometries and analyzing true surface properties and reaction characteristics using a variety of electronic, chemical, and electrochemical techniques.