Regenerative perovskites for a resilient resource-efficient future

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Currently, the most important and urgent challenges are directly related to energy and environmental issues. Performance degradation or aging behavior in energy conversion and storage materials has been the focus of many research areas. Research in halide perovskite solar cells has exhibited that the stability is still below the requirements for a commercial application. Rechargeable batteries become less effective as they chemically age. The best water splitting materials for the electrocatalytic oxygen evolution reaction should balance stability and activity. Solid oxide fuel cells for electricity generation and solid oxide electrolysis cells for H_2 production are not commercialized mainly due to cell durability let alone the costs. All the examples listed above imply that it is not easy to obtain materials with enhanced life time and better performance simultaneously, let alone the sustainability and security into consideration. In this regard, developing materials which can be regenerated, self-repaired, and self-healed remains a critical challenge.

In this work, as one of the examples, regenerative behavior of perovskite-type oxides will be presented. Different perovskite-type oxides with regenerative properties were studied by thermogravimetric analysis and in situ X-ray diffraction. The correlation between oxidation-reduction reaction and crystal lattice changes is discussed. It is anticipated that this finding and understanding would serve as an initial platform to develop strategies to circumvent the paradox of efficiency and stability, opening up opportunities and approaches to produce the highly active energy converters with a desired lifetime from available resources.