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Nonstoichiometric Perovskite Oxides for Solar Thermochemical H_2 and CO Production

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Perovskite oxides (ABO_3) are a largely unexplored class of materials in solar fuel applications. In this presentation we examine the use of nonstoichiometric perovskite-type oxides in a two-step, solar-thermochemical water or carbon dioxide splitting cycle. We find that a substituted $SrMnO_3$ will split both H_2O and CO_2. And the yield of H_2 and CO is significantly greater than CeO_2, a benchmark material in CSP fuels research, at a thermal reduction temperature 150 °C below that of CeO_2. Constant redox activity was demonstrated over 80 cycles. To put this discovery in perspective, efforts to improve upon ceria's performance that are focused on destabilizing the crystal structure through doping or substitution have only marginally increased cycle capacity. It is unlikely that these enhancements to CeO_2 will prove sufficiently beneficial at reduction temperatures below 1400 °C. In addition, the amenability of the perovskite structure to chemical modification opens a vast composition space within which to design more effective materials that will greatly exceed the performance of ceria. The profound impacts on the development of concentrating solar power fuels technologies will be addressed.

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