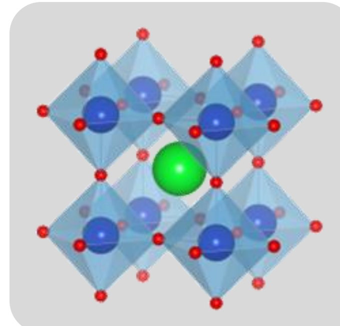
SAND2014-3388P

Exceptional service in the national interest

Sandia National Laboratories

Thermochemical Energy Storage Materials for Concentrating Solar Towers

Mixed ionic-electric conductivity metal oxides store energy in chemical bonds reversibly in temperature cycles.



Chemical rather than physical storage provides more energy and energy-on-demand in CSP technologies.

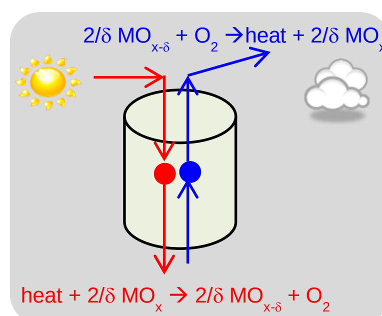
Andrea Ambrosini, aambros@sandia.gov
Anthony Martino martino@sandia.gov

Problem Statement:

A critical factor limiting the integration of Concentrating Solar Power (CSP) into the world's energy portfolio is the lack of cost- and energy-efficient thermal energy storage. Current plants employ molten salts to store and transport sensible heat, but challenges exist: salt-promoted corrosion, limited temperature range (238-600°C), low thermal conductivity, and limited heat storage capacity. In addition, molten salts are inadequate for next-generation, high temperature (>600°C) CSP plants. Thermochemical energy storage (TCES) offers the potential for greatly increased storage density (potentially >10X) and considerably expands the applicable temperature range. Moreover, heat stored in chemical bonds can be stored indefinitely and accessed upon demand. Sandia is developing new TCES materials.

Approach:

The requirements of an ideal TCES system (high reaction enthalpy, full reversibility, temperature/power cycle matching, acceptable reaction kinetics, long-term stability, low cost) cannot all be met by existing technology; the development of new materials is required. We are developing TCES materials based on the cyclic endothermic reduction and exothermic oxidation of novel metal oxides with mixed ionic-electronic conductivity (MIEC). The compositions and structure of these materials can be designed to provide ample redox capacity not accompanied by phase changes that can slow reaction rates or threaten the physical integrity of particles. They also accommodate rapid oxygen ion and electron transport to facilitate deep and rapid utilization of the bulk material (i.e., non-surface). Preliminary studies of MIEC perovskite oxides developed at Sandia have shown the ability of these materials to reduce at temperatures in excess of 1300 °C. These compositions are chemically stable over multiple redox cycles, exhibit rapid kinetics, and are resistant to sintering.



Impact:

The development of a TCES system for next-generation CSP will enable CSP plants to produce electricity even in times of prolonged solar outages. This will help make solar cost-competitive with other energy platforms and increase penetration of CSP into the current energy portfolio.

U.S. Department of Energy NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2011-XXXXP

Sandia National Laboratories