

PROMISING CERIUM-DOPED BARIUM MANGANATE PEROVSKITE FOR SOLAR THERMOCHEMICAL HYDROGEN PRODUCTION

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Over the past decade, nonstoichiometric oxides have been investigated for solar thermochemical water splitting applications because of their ability to partially reduce and create oxygen vacancies at high temperatures and subsequently reoxidize in steam at lower temperatures, uptaking the oxygen into the lattice and producing hydrogen as a consequence (c.f. Figure 1a).

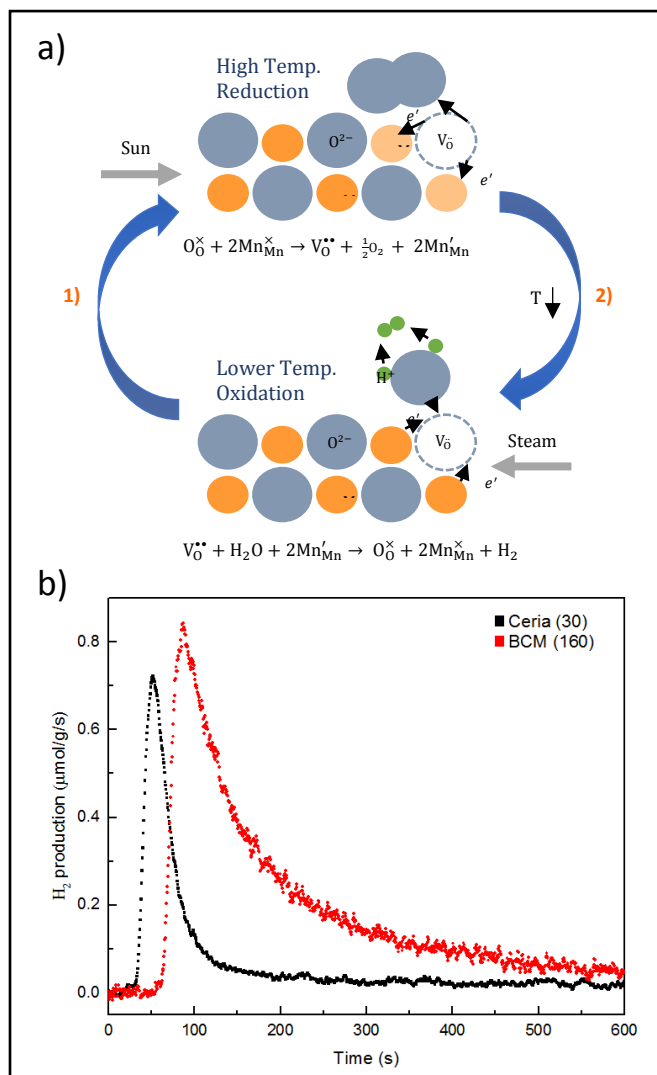


Figure 1 – a) Illustration of Solar Thermochemical Hydrogen production cycle where the Mn changes the oxidation state to accommodate for the oxygen vacancy formation. b) Hydrogen yield comparison for cerium doped barium manganate and ceria.

Ceria is currently viewed as the leading candidate for this process because of its fast reoxidation reaction kinetics and considerable H₂ yield. However, high temperatures (>1550°C) are required to drive ceria reduction, making the reactor and the solar heat collector design challenging. Furthermore, a low steam oxidation temperature is preferred from a reactor energy balance stand-point.

To address these needs, we have been screening new potential materials for solar thermochemical water splitting among the perovskite oxides, which are well known for their compositional tunability and ability to accommodate large changes in oxygen nonstoichiometry. As a result of these screening studies, we have identified cerium-doped barium manganate (BCM) as an intriguing (and lower cost) potential alternative to ceria. Water splitting experiments using the Stagnation Flow Reactor (SFR) at Sandia National Laboratory show that BCM yields ~5 times more H₂ than ceria (per unit mass oxide) at a reduction temperature of 1350°C and oxidation temperature of 850°C with 40% steam. The 5X increase in H₂ yield per gram of BCM results in 16X lower materials cost compared to CeO₂.