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ABSTRACT:

Mixed Metal Oxides for Enhanced Solar Fuel Production Via Thermochemical Redox Cycling

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The area of solar thermochemistry aims at direct thermochemical production of chemical fuels and advanced thermochemical processing of materials. Cheap and efficient solar production of synthesis gas (syngas), the precursor to synthetic drop-in hydrocarbon fuels such as petrol, diesel and kerosene, is an intriguing approach to transform today's fossil-based to tomorrow's renewable-based transportation sector. Solar-driven thermo- chemical redox cycles have been demonstrated as a promising approach to water and carbon dioxide splitting. While direct on-sun high-temperature reduction has been demonstrated with various metal oxides, cerium diox- ide (ceria) remains the reference metal oxide. Main challenges are related to long-term cyclic chemical and mechanical stability of metal oxide structures at high temperatures required for the direct reduction step. The process conditions become less challenging when solar-driven carbothermal reduction is employed. We have investigated ceria-based and ceria-doped mixed metal oxide partial methane oxidation coupled to redox cycling for enhanced syngas production, materials stability and system scalability. Intriguing interplay effects were found to improve structural and catalytic properties in ceria-containing compositions, of which some resulted in unprecedented fuel production rates using reticulate porous ceramic structures.

Biography
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