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# OXIDE PARTICLES AS COMBINED HEAT STORAGE AND SULPHUR TRIOXIDE DECOMPOSITION CATALYSTS FOR SOLAR HYDROGEN PRODUCTION THROUGH SULPHUR-BASED CYCLES

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## ABSTRACT

Among the many thermochemical cycles schemes tested for hydrogen production via water-splitting, those of the sulphur family recycle sulphur as the central element that appears in different compounds at changing oxidation state. These cycles involve two or more steps and have in common the decomposition reaction of sulphuric acid: first to steam and $SO_3$ and subsequently the $SO_3$ dissociation to $SO_2$ and oxygen. The latter is their highest-temperature (700-900$^oC$), endothermic reaction step that can be aided by heat supplied by concentrated solar power.

Within the general framework of investigating novel power cycles for renewable electricity/solar hydrogen production, combining a solar centrifugal particle receiver with a sulphur storage system for baseload operation, the present work concerns the synthesis, development, evaluation and characterization of particles suitable to operate as media for direct solar irradiation absorptance, heat transfer and thermal storage as well as catalysts for the $SO_3$ decomposition reaction. In this perspective, commercial bauxite-based proppants were progressively modified accordingly, to incorporate oxides known for their catalytic activity with respect to $SO_3$ decomposition, namely iron, copper, manganese oxides and their combinations. Such non-modified and modified proppants were tested with respect to $SO_3$ decomposition in fixed bed reactor test rigs at 850$^oC$ and ambient pressure with concentrated liquid sulfuric acid (96%wt) as feedstock. Extensive screening tests have identified several of these systems that not only could achieve $SO_3$ conversions close to the equilibrium ones, but exhibited stable performance over 125 hrs of continuous operation. These results are used in conjunction with physicochemical properties measurements before and after catalytic testing; specifically phase composition, absorptance and crushing strength to proceed to large-scale synthesis of compositions exhibiting the best combination of such properties and their eventual testing in a pilot-scale solar reactor.

**Keywords:** Hydrogen production, solar fuel, concentrated solar power, Sulphur-based thermochemical cycles, oxide catalysts, particle reactors.