Hydrogen Production via Water Splitting in Solar Reactors: the Hydrosol Process

Athanasios G. Konstandopoulos[a,b,*], C. Sattler[c], P. Stobbe[d], A.M. Steele[e]
[a]*Aerosol & Particle Technology Laboratory, CERTH/CPERI, P.O. Box 361, Thermi, Thessaloniki 57001, Greece and* [b] *Department of Chemical Engineering, Aristotle University, P.O. Box 1517, 54006, Thessaloniki, Greece*
[c]*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Technische Thermodynamik, Solarforschung, D-51170 Köln, Germany*
[d]*Stobbe Tech Ceramics, Vejlemosevej 60, DK-2840, Holte, Denmark*
[e]*Johnson Matthey Technology Centre, Sonning Common, RG4 9NH, Reading, UK*
**E-mail: agk@cperi.certh.gr*

The present work reviews recent work in the field of solar thermochemical hydrogen production via water splitting in monolithic reactors, also known as the Hydrosol process. The process employs a reactor concept, adapted from the well-known automotive emission control field, and consists of multichannel ceramic honeycombs, coated with active water-splitting materials, that are heated by concentrated solar radiation to the desired temperature.. When water vapor passes through the reactor, the coating material splits the water molecule by "trapping" its oxygen and leaving in the effluent gas stream pure hydrogen. In a next step, the oxygen "trapping" material is regenerated, by increasing the amount of solar heat absorbed by the reactor; hence a cyclic operation is established. Multi-cyclic solar thermo-chemical splitting of water was successfully demonstrated on a pilot solar reactor achieving constant hydrogen production exclusively at the expense of solar energy. The presentation addresses the synthesis of active water-splitting materials, their deposition upon the ceramic monoliths, the testing of relevant properties of merit such as the thermomechanical stability and hydrogen yield and finally the design, simulation operation and performance optimization of structured monolithic solar hydrogen production reactors.