Thermochemical Reactions for Solar Energy Storage and Fuel Production

Martin Roeb* and Christian Sattler

Institute of Solar Research, German Aerospace Center (DLR), Köln 51170, Germany;
E-Mails: martin.roeb@dlr.de ; christian.sattler@dlr.de

Thermochemical multistep processes are promising options to face future energy problems. Such reactions can be used to enhance the availability of solar energy in terms of energy transport, of energy demand/supply management and of potential energy related applications. Coupling concentrated sunlight to suitable sequences of thermochemical reaction enables the production of hydrogen, syngas and other fuels derived from those precursors by water- and CO_2-splitting as well as the storage of solar energy by breaking and forming chemical bonds in suitable reversible reactions. These processes are sustainable and environmentally attractive since only water, CO_2 and solar power are used as “raw materials”. All other materials involved are recycled within the process. The concentrated solar energy is converted into storable and transportable chemicals and fuels. One of the major barriers to technological success of many of those processes is the identification of suitable active materials like catalysts and redox materials exhibiting satisfactory durability, reactivity and efficiencies. Moreover, materials play an important role in the construction of key components of the respective high-temperature processes and for the implementation in commercial solar plants. Besides materials aspects also process engineering issues needs to be overcome. One of the most striking challenges is to couple an intermittent energy source to a chemical process. The most promising thermochemical processes are being described and discussed with respect to further development and future potential. The main challenges of those processes are being analyzed. Technical approaches and development progress in terms of solving them are addressed and assessed.