Thermochemical solar energy storage via functionalized porous ceramic structures

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Thermochemical storage of solar heat in Concentrated Solar Power (CSP) plants exploits the heat effects of reversible chemical reactions: solar heat produced during on-sun operation is used to power an endothermic chemical reaction; if this reaction is completely reversible the thermal energy can be entirely recovered by the reverse reaction during off-sun operation. Redox reactions of multivalent solid oxides in particular, can be directly coupled to CSP plants using air as heat transfer fluid, since in this case air can be simultaneously used as a reactant in the storage system.
In such applications, the inherent advantages of porous ceramic foams/honeycombs i.e. high geometric surface area, good gas-solid contact, accommodation of high gas flow rates with low pressure drop and enhanced heat transfer, can be combined with the incorporation in their structure of suitable redox oxides capable for cyclic redox operation with high reaction heat effects. Tests on such laboratory-scale structures using cobalt oxide as a model redox system are presented, demonstrating its efficient long-term cyclic operation. Properly engineered application-specific, modular thermochemical reactor/heat exchanger concepts are also proposed to enhance the utilization of heat transfer fluid enthalpy.