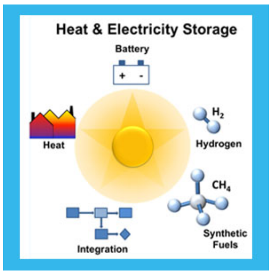

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Conversion of electricity into hydrogen using a dual-circuit redox flow battery

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Redox flow batteries (RFBs) are very well suited for storing the intermittent excess supply of renewable electricity [1]. However, conventional RFBs cannot in many situations utilize all the available "junk"electricity due to a limited storage capacity, as they are charged and discharged electrochemically, with electricity stored as chemical energy in the electrolytes. In the RFB system reported here, the electrolytes are conventionally charged but are then chemically discharged over catalytic beds in separate external circuits.

Recently we demonstrated a rapid chemical discharge of the battery chemically to produce hydrogen rapidly and efficiently [2]. The proposed system is able to generate hydrogen gas as secondary energy storage. For demonstration, indirect water electrolysis was performed with vanadium-cerium RFB, generating hydrogen and oxygen in separate catalytic reactions. The electrolyte containing V(II) was chemically discharged through proton reduction to hydrogen on a molybdenum carbide catalyst, whereas the electrolyte comprising Ce(IV) was similarly discharged in the oxidation of water to oxygen on a ruthenium dioxide catalyst.

The dual-circuit RFB requires an efficient and low-cost catalyst for hydrogen evolution. We have recently demonstrated that molybdenum carbide (Mo2C) can be utilized to catalyze hydrogen evolution by an electrolyte containing vanadium(II), resulting in 100 % yield of hydrogen.2 Here we will present the latest results on the Mo2C catalyzed hydrogen evolution reaction, including an ongoing project to scale-up the hydrogen production process to the demonstrator level using a 10 kW dual-circuit all-vanadium redox flow battery.

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2. V. Amstutz, K. E. Toghill, F. Powlesland, H. Vrubel, C. Comninellis, X. Hu, H. H. Girault, Energy Environ. Sci., 2014, 7, 2350-2358.

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