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A Precious-Metal Free Regenerative Fuel Cell for Storing Renewable Electricity

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There have been extensive research efforts focusing on developing technologies for renewable electricity, particularly solar photovoltaics and wind turbines. However, the intermittent and localized nature of wind and solar energy necessitates the development of a cost-effective way to balance energy supply and demand and to deliver electricity from remote places to cities.[1] The short-term option is the electricity grid; however, it can only support intermittent renewable electricity in a stable fashion up to approximately 20 % of grid capacity which means that fossil resources would still account for the remaining 80 % of grid electricity.[2] Clearly, the development of cost-effective energy storage devices is needed to establish a path toward fossil-free energy.

Pumped hydro currently dominates grid-scale energy storage due to its low cost but is hindered by a lack of suitable geographical sites.[3] Hence, there has been interest in developing alternative cost-effective energy storage technologies that can be rapidly scaled-up. Regenerative fuel cells (RFCs) are interesting candidates: a RFC is an electrochemical energy storage and conversion device that typically uses H_2 as an energy carrier. RFCs possess high specific energies, enjoy economies-of-scale advantages, are modular in nature, and use only environmentally friendly and inexpensive reactants.[4,5] However, RFCs are currently too expensive to compete with existing energy storage technologies.[5]

Herein, we demonstrate a prototype alkaline exchange membrane unitized RFC (AEM-URFC) that stores energy based on electrochemical interconversions among H_2O, H_2, and O_2, with the key development of having done so in a low-temperature, precious-metal free device operating at low temperatures while avoiding the use of precious metal catalysts. The prototype device we have developed obtains round trip efficiencies of 34-40 % at 10 mA/cm^2 over 8 cycles, with a peak power density of 17 mW/cm^2 in fuel cell mode. This report of a precious-metal free AEM-URFC opens up new possibilities for enabling cost-effective and widespread deployment of renewable electricity.

References

[1] Z. Zhan, W. Kobsiriphat, J.R. Wilson, M. Pillai, I. Kim, S.A. Barnett, *Energ. Fuel.* **2009**, *23*, 3089.
[2] W. Kempton, J. Tomić, *J. Power Sources* **2005**, *144*, 280.
[3] A. Oudalov, T. Buehler, D. Chartouni, presented at Energy 2030 Conference, Atlanta, Georgia, USA, November **2008**.
[4] F. Barbir, T. Molter, L. Dalton, *Int. J. Hydrogen Energ.* **2005**, *30*, 351.
[5] S. Lichtner, R. Brindle, L. Kishter, L. Pack, W. Hunt, Nexight Group. **2010**.