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The Proton Flow Battery for Storing Renewable Energy: Hydrogen Storage Capacity of Selected Activated Carbon Electrodes Made from Brown Coal

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Abstract : Electrochemical storage of hydrogen in activated carbon electrodes as part of a reversible fuel cell offers a potentially attractive option for storing surplus electrical energy from inherently variable solar and wind energy resources. Such a system – which we have called a proton flow battery – promises to have roundtrip energy efficiency comparable to lithium ion batteries, while having higher gravimetric and volumetric energy densities. Activated carbons with high internal surface area, high pore volume, light weight and easy availability have attracted considerable research interest as a solid-state hydrogen storage medium. This paper compares the physical characteristics and hydrogen storage capacities of four activated carbon electrodes made by different methods from brown coal. The fabrication methods for these samples are explained. Their proton conductivity was measured using electrochemical impedance spectroscopy, and their hydrogen storage capacity by galvanostatic charging and discharging in a three-electrode electrolytic cell with 1 mol sulphuric acid as electrolyte. The highest hydrogen storage capacity obtained was 1.29 wt%, which compares favourably with metal hydrides used in commercially available solid-state hydrogen storages. The hydrogen storage capacity of the samples increased monotonically with increasing BET surface area (calculated from CO2 adsorption method). The results point the way towards selecting high-performing electrodes for proton flow batteries that the competitiveness of this energy storage technology.

Keywords : activated carbon, electrochemical hydrogen storage, proton flow battery, proton conductivity
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