

## Solar Energy South Africa

# Bahrain energy storage membranes



Voltage range: 691.2-947.2V

>6000 cycles (100%DOD)

Rated battery capacity:  
216KWH (customizable)

EMS communication:  
4G/CAN/RS485

## Overview

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Can hydrocarbon membranes be used in terawatt-scale flow batteries?

Future terawatt-scale deployment of flow batteries will require substantial capital cost reduction, particularly low-cost electrolytes and hydrocarbon ion exchange membranes. However, integration of hydrocarbon membranes with novel flow battery chemistries in commercial-scale stacks is yet to be demonstrated.

How efficient is the Speek membrane?

To further demonstrate the performance of the SPEEK membrane, we scaled up the flow battery cell stacks ranging from 300 to 4,000 W with membrane areas scaled up from 4,375 cm<sup>2</sup> to 3 m<sup>2</sup>, and the energy efficiency of the stack remained nearly unchanged (Figure 5 B).

Can hydrocarbon-based cation-exchange membranes be used in alkaline battery systems?

To date, there are relatively few attempts to apply hydrocarbon-based cation-exchange membranes in novel alkaline battery systems in laboratory scale;<sup>24,29,30</sup> however, the long-term stability and performance remain to be improved.

Can we develop low-cost sustainable membranes with high stability and ionic conductivity?

There is an urgent need to develop low-cost sustainable membranes with high stability and ionic conductivity. We demonstrate the pilot-scale roll-to-roll synthesis of SPEEK membrane and the upscaling of zinc-iron flow battery stack from 300 W to 4,000 W with membrane area up to 3 m<sup>2</sup>.

What are the advantages of a battery membrane?

The membranes significantly surpass the limit performance of most of existing membrane materials, which enables efficient and highly stable battery

performances and long-duration storage up to 14 h.

How efficient is a nafion membrane?

The membrane was integrated in flow battery stacks with power up to 4,000 W, which demonstrated a high energy efficiency of 85.5% operated at 80 mA cm<sup>-2</sup> and long-term stable operation over 800 h as well as substantial cost savings relative to Nafion membranes.

## Bahrain energy storage membranes

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### MXene Nanosheets and Carbon Nanofiber Hybrid ...

and advanced energy storage systems is crucial [1]. To meet the sharply increasing demand for various types and quantities of portable wearable electronic products, the need for advanced energy storage systems is growing [2]. Therefore, many exible wearable energy storage devices have attracted widespread attention [3].

### Giant energy storage of flexible composites by embedding

The proposed composites containing flexible 2D inorganic membranes offer unprecedented structural insights into the integration of high energy storage and stability of bending, and suggest potential uses in flexible energy storage devices. KW - Composites. KW - Energy storage. KW - Flexible. KW - Single crystals. KW - Superparaelectric



### Bahrain's Bright And Sustainable Future: A Comparative ...

Bahrain's proposed renewable energy pipeline consists of solar, wind, and waste to energy technologies, with the SEA intending to capture the majority of Bahrain's renewable energy mix from solar power. The SEA is planning for a solar farm project on the Askar landfill, delivering 100 megawatts of renewable power.

## Low-cost hydrocarbon membrane enables commercial-scale flow ...

The membrane was integrated in flow battery stacks with power up to 4,000 W, which demonstrated a high energy efficiency of 85.5% operated at  $80 \text{ mA cm}^{-2}$  and long-term stable operation over 800 h as well as substantial cost savings relative to Nafion membranes. This work illustrates a potential pathway for manufacturing and upscaling of next

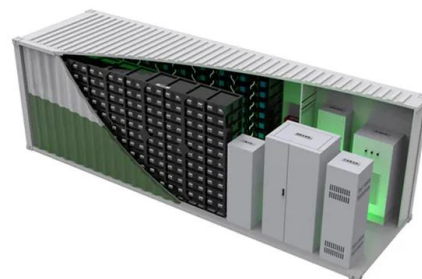


## Multifunctional polymer electrolyte membrane networks for energy

A novel concept of energy storage is presented involving ion-dipole complexation within a multifunctional polymer electrolyte membrane (PEM). By virtue of the network functional groups, the ion transport is hindered which may be viewed as temporally holding of the Li ions, reminiscent of ion storage.

## New Membrane Technology Improves Water ...

A redox flow battery that could be scaled up for grid-scale energy storage. Credit: Qilei Song, Imperial College London Imperial College London scientists have created a new type of membrane that could improve ...



## A compact modular microchannel membrane-based absorption thermal energy

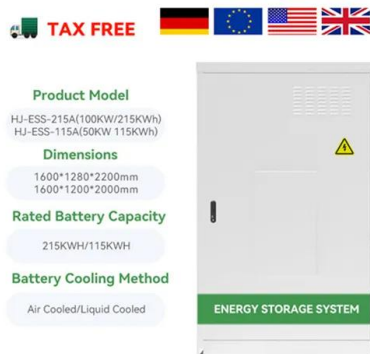


Energy storage density (ESD) refers to the amount of energy stored per unit volume within the system. Sensible thermal energy storage is the most established and cost-effective method for thermal energy storage, which has a wide range of applications in solar energy systems, such as solar preheaters and desalinations [5].

## The Acid-Base Flow Battery: Sustainable Energy Storage via

...

Keywords: flow battery, energy storage, bipolar membrane, reverse electrodialysis, bipolar membrane electrodialysis, water dissociation. 1. Introduction. The awareness of climate change and its alarming impact has resulted in the recognition of urgent need for ...



## Fast ionic PEO- NaCF<sub>3</sub>SO<sub>3</sub>-Na<sub>3</sub>Zr<sub>2</sub>Si<sub>2</sub>P<sub>3</sub>O<sub>12</sub> membranes for

These hybrid composite films/membranes have recently been used in solid-ionic energy storage devices. For instance, NaMnPO<sub>4</sub> nanoparticles were used to synthesize electrolyte using the solution combustion method. The device exhibited a maximum specific capacitance value of 83Fg<sup>-1</sup> (at 1Ag<sup>-1</sup>) and achieved 89 % capacitance retention after 1000 ...

## Xie Xian NING, et al. : Energy-Storage Membrane

A highly polarizable ion-conducting energy-storage membrane capacitor demonstrates

simplicity, easy device scaling up and low fabrication cost for electrical energy storage. This material system also presents a high cycle life at maintained performance. The membrane-based capacitor can have an average capacitance of  $\sim 0.2 \text{ F/cm}^2$ , energy of  $0.33 \text{ J}$



## Large-area, self-healing block copolymer membranes for energy ...

We introduce a self-assembly strategy that  
 uses the interface of an aqueous two-phase system to template and stabilize molecularly thin biomimetic block copolymer bilayers of scalable area



## Graphene oxide membranes for electrochemical energy storage ...

Although the improvement was considerable, the commercial membrane is expensive for the development of low-cost energy storage systems, and there is less flexibility in modifying the membrane. In a similar design, Yao et al. employed an inexpensive polypropylene (PP) membrane and covered its surface with carbon to avoid the migration of the



## Subsea Energy Storage System

An example with a fixed platform with five 5,000 m<sup>3</sup> storage units, gives a total storage volume of 25,000 m<sup>3</sup>. Energy storage with ammonia, given the density of ammonia, gives 19,000 tons of

fuel. Each ton of ammonia gives 5,17 MWh of energy, if it is used as direct fuel.



## Macro-scale Turing-shape membranes for energy storage

Herein, we applied Turing-shape membranes to vanadium flow battery (VFB), one of the most promising electrochemical devices for large-scale energy storage, since the PBI membrane has proved to perform very well in a VFB. 23 In a VFB, a membrane plays the role of isolating vanadium ions and transporting protons, where high selectivity on



## MXene Nanosheets and Carbon Nanofiber Hybrid Membranes for

In recent years, due to global warming and the continuous consumption of energy resources, the development of clean and advanced energy storage systems is crucial [1]. To meet the sharply increasing demand for various types and quantities of portable wearable electronic products, the need for advanced energy storage systems is growing [1]. Therefore, ...

## Fine-tuning ion exchange membranes for better energy storage

The results will make it possible to build longer lasting and more cost- and energy-efficient devices such as flow batteries, a promising technology for long-duration grid-scale energy storage, by creating an exchange membrane that lets ions cross rapidly, giving the device greater energy efficiency, while stopping electrolyte molecules from



## Advanced Membranes for Energy Storage and Conversion

It is imperative to develop advanced membranes for energy storage and conversion device. A qualified membrane should be endowed with high ionic conduction, electrical insulation, high safety, long-term stability and low cost. Additionally, increasing challenging demands for membranes with novel structures and multi-functions have prompted

## Advanced membranes for electrochemical energy storage ...

This PhD project aims to design and synthesis novel membrane materials with tailored ion selectivity and high ionic conductivity for electrochemical energy storage devices, such as redox flow batteries, sodium ion batteries, zinc ion battery through innovative material engineering and chemical functionalisation.



## Cellulose-derived solid-solid phase change thermal energy storage



The thermal energy storage performance of the resulted ALs/CUE-AAs membranes (e.g., AL 16 /CUE-AA 16, AL 18 /CUE-AA 18, and AL 22 /CUE-AA 22) was further evaluated in comparison with that of CUE-AAs-3 membranes (Fig. 6 a-b and Table S4). ALs in CUE-AAs cross-linked network still present excellent molecular mobility due to physical filling

## Two-dimensional material separation membranes for renewable energy

The current energy crisis has prompted the development of new energy sources and energy storage/conversion devices. Membranes, as the key component, not only provide enormous separation potential



## Giant energy storage of flexible composites by embedding

Among energy storage candidates, relaxor ferroelectric oxide thin films have received considerable attention owing to their remarkable energy storage density ( $U$ ,  $>100 \text{ J/cm}^3$ ), achieved by establishing nanodomains or nanocrystalline grains [8], [9]. Nevertheless, the vigorous development of flexible electronics is still limited by the inflexible aspect of inorganics, ...

## Fine-tuning ion exchange membranes for better energy storage

Nano-scale changes in structure can help

optimise ion exchange membranes for use in devices such as flow batteries. Research that will help fine-tune a new class of ion exchange membranes has been published in Nature\* by researchers at Imperial, supported by colleagues at a range of other institutions. The results should make it possible to build longer ...



## Giant energy storage of flexible composites by embedding

Giant energy storage of flexible composites by embedding superparaelectric single-crystal membranes. Author links open overlay panel Tian Wang a 1, The as-obtained Sm-BFBT oxide membranes with outstanding energy storage properties and flexibility will be promising fillers for flexible polymer-based composites capacitors.

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