

## European Solar Energy Storage

# Membraneless flow battery Antigua and Barbuda



## Overview

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Are membrane-free batteries cyclable?

While membrane-free batteries have been successfully demonstrated in static batteries, membrane-free batteries in authentic flow modes with high energy capacity and high cyclability are rarely reported. Here, we present a biphasic flow battery with high capacity employing organic compound in organic phase and zinc in aqueous phase.

What is a membrane-free redox flow battery?

A membrane-free redox flow battery with high energy density is presented. The designed flow battery delivers a capacity retention of 94.5% over 190 cycles. Operando UV-visible and FT-IR spectroscopies are performed to elucidate capacity decay mechanism.

Are membrane-free batteries based on microfluidic electrolytes suitable for large-scale energy storage?

Laminar flow has been successfully utilized in developing micro-fuel cells , , yet these batteries are based on microfluidic electrolytes, which are not suitable for large-scale energy storage. Recently, immiscible electrolyte-enabled membrane-free batteries are proposed [25, , , , , , , , ].

Can membrane-free flow batteries be used for energy storage?

The power density of the membrane-free RFBs can be further improved by decreasing the distance between electrodes and increasing the ionic conductivity of electrolytes. This work opens a new avenue of using membrane-free flow batteries for affordable large-scale energy storage.

Are membranes suitable for non-aqueous battery systems?

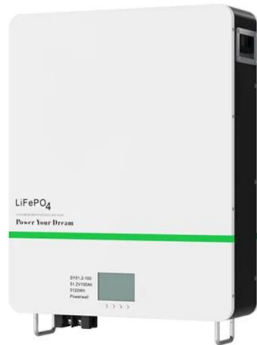
Furthermore, these membranes are not appropriate for non-aqueous battery systems due to their limited properties in non-aqueous electrolytes, such as low ionic conductivity, poor ion selectivity, and low chemical stability [38,39].

Does water affect the capacity fade mechanism of membrane-free batteries?

To probe the capacity fade mechanism of the membrane-free batteries, it is essential to first study the stability of the TEMPO and C3-PTZ electrolytes. The CV tests in different systems with or without saturated water were conducted to explore the influence of the water on the redox behavior.

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### Membraneless Biphasic Redox Flow Batteries: Interfacial Effects ...

A new concept of membraneless battery based on immiscible aqueous and nonaqueous stratified-electrolytes was studied in a static cell for the purpose of constructing a redox flow battery (RFB).

### Amazon pilots revolutionary membraneless flow battery

Zurich/London, 29. October 2024 - Amazon is trailing a new battery technology for its energy storage needs in cooperation with the Swiss battery startup, Unbound Potential, a participant of the Amazon Sustainability Accelerator. Unbound Potential has developed a membraneless redox flow battery that, unlike



### Ionic liquid redox flow membraneless battery in microfluidic ...

adshelp[at]cfa.harvard The ADS is operated by the Smithsonian Astrophysical Observatory under NASA Cooperative Agreement NNX16AC86A

### Amazon and Unbound Potential to pilot Redox-Flow battery

Unbound Potential has developed a membrane-less redox flow battery that, unlike conventional lithium-ion batteries, does not require any critical raw materials. Instead of ...



## Membraneless flow battery leveraging flow-through ...

We propose and demonstrate a novel flow battery architecture that replaces traditional ion-exchange membranes with less expensive heterogeneous flow-through porous media. ...

## Membraneless Biphasic Redox Flow Batteries: Interfacial Effects ...

The MB-Br flow battery was constructed using membrane-free 0.1 m MB in 15 m LiTFSI as the anolyte solution and 0.5 m LiBr in 12 m LiCl as the catholyte under a 10 mL min ...



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## Membraneless Micro Redox Flow Battery: From Vanadium to ...

First proof-of-concept of a membraneless micro redox flow battery with an automated closed-loop control, using micro actuators and micro sensors, during charge-discharge continuous operation in recirculation mode is presented in this work. A maximum value of 60 % State of

Charge with commercial Vanadium electrolyte, monitored via online spectrometry, is achieved, with a ...

## Amazon and Unbound Potential to pilot Redox-Flow battery

Unbound Potential has developed a membrane-less redox flow battery that, unlike conventional lithium-ion batteries, does not require any critical raw materials.. Instead of using a membrane, the ion exchange is controlled by non-miscible electrolytes, which Unbound Potential said makes the battery more durable and requires 90 per cent fewer sealing surfaces.



## Membraneless flow battery leveraging flow-through ...

nanoporous separators (for reduced crossover) to enable a high performance, cyclable membraneless flow battery. While previous membraneless cells have used flow-through porous electrodes (albeit with flow largely parallel to electric field),<sup>13,18,19</sup> or nanoporous separators,<sup>10,17</sup> no previous system to our knowledge has combined these two concepts.

## Prospects of recently developed membraneless cell designs for ...

As is the case for a membrane-based flow battery, the electrolytes of a membraneless flow battery must be readily reusable. Reusability ( R ) can be defined with reference to electrolyte volume in each half cell: (1) Reusability ( R ) = Volume of r eactant ( s ) recoverable Total volume o f r e actant ( s ) before first pass



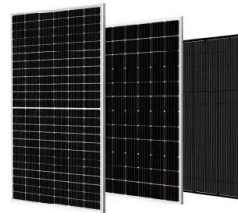


## Membraneless Biphasic Redox Flow Batteries: Interfacial Effects ...

The wider adoption of redox flow batteries (RFBs) is hindered partly by the high cost of ion-exchange membranes. Membrane-free batteries have recently emerged as a potential alternative to traditional RFBs, with the redox anolyte and catholyte confined to immiscible aqueous and non-aqueous phases.

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nanoporous separators (for reduced crossover) to enable a high performance, cyclable membraneless flow battery. While previous membraneless cells have used flow-through porous electrodes (albeit with flow largely parallel to electric field),<sup>13,18,19</sup> or nanoporous separators,<sup>10,17</sup> no previous system to our knowledge has combined these two concepts.



## Resistance Breakdown of a Membraneless Hydrogen-Bromine Redox Flow Battery

In Figure Figure4 4, we show the results of a discharge polarization curve measurement on our prototype membraneless H<sub>2</sub>-Br<sub>2</sub> flow battery. We observe an OCV of ~0.94 V, followed by a linear region with voltage loss linearly proportional to current density to over 1 A/cm<sup>2</sup> and evidence of mass transport losses at higher current densities.

## Performance Evaluation of a Scaled-Up Membraneless

## Organic ...

This article presents an evaluation of the performance of a membrane-less organic-based flow battery using low-cost active materials, zinc and benzoquinone, which was scaled up to 1600 cm<sup>2</sup>, resulting in one of the largest of its type reported in the literature. The charge-discharge cycling of the battery was compared at different sizes and current densities, ...



## Cyclable membraneless redox flow batteries based on immiscible ...

Here, we present a new design of macroscale membraneless redox flow battery capable of recharging and recirculation of the same electrolyte streams for multiple cycles and maintains the advantages of the decoupled power and energy densities. The battery is based on immiscible aqueous anolyte and organic catholyte liquids, which exhibits high

## Resistance Breakdown of a Membraneless Hydrogen ...

transmission line circuits to represent porous battery and flow battery electrodes, generally the solid phase electric resistance was justifiably neglected.<sup>31,32</sup> However, in high power density flowbatteries, such an assumption must be relaxed due to the high electrolyte ionic conductivity.<sup>16,33</sup> Other assumptions invoked here are typical for



## Membraneless Biphasic Redox Flow Batteries: Interfacial Effects ...

Ion-exchange membranes also add to cell resistance and can reduce battery life. Three general approaches to improve the performance, and reduce costs, of RFBs have been pursued to date. The first strategy is to utilize non-aqueous electrolytes to increase the energy density, by extending the voltage window beyond the ca. 2.0 V maximum obtained



## Polarization curves of membraneless microfluidic vanadium redox flow ...

Membraneless micro redox flow batteries prevent the advective mixing of catholyte and anolyte by operating at a small Reynolds number with flow rates of order 100 $\mu$ L/min or less [1] [2] [3] [4].



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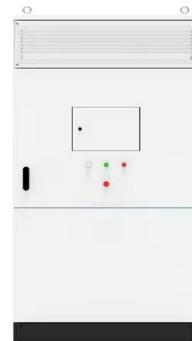
## Membraneless Micro Redox Flow Battery: From Vanadium

**to ...**

The membraneless Micro Redox Flow Battery used in this research is based on the one presented by Oraá-Poblete et al. 21 with an improvement of the electrical external contacts. The details of reactor design and microfluidic system are explained in S1 of Supporting Information. For the electrochemical characterization, commercial Vanadium

## Membrane-less hybrid flow battery based on low-cost elements

The performance of a membraneless flow battery based on low-cost zinc and organic quinone was herein evaluated using experimental and numerical approaches. Specifically, the use of zinc fiber was



## [1610.04338] Membraneless flow battery leveraging flow-through

Here, we propose and demonstrate a novel flow battery architecture that replaces traditional ion-exchange membranes with less expensive heterogeneous flow-through ...

## Membrane-less hybrid flow battery based on low-cost elements

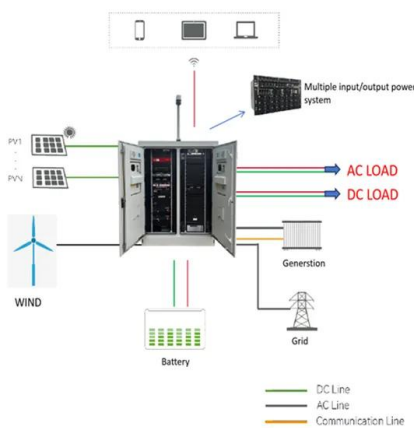
The charge-discharge performance of the electrode reactions was evaluated in a

commercial flow battery (Proingesa, Spain) based on a membrane-less configuration, similar to that in previous work [42]. Fig. 2 shows the experimental arrangement and electrolyte circuits of the proposed system. The single cell consisted of two electrodes, two acrylic flow channels (2 ...



## Membrane-Less Hydrogen Iron Redox Flow Battery

In this study, a new type of redox flow battery (RFB) named "membrane-less hydrogen-iron RFB" was investigated for the first time. The membrane is a cell component dominating the cost of RFB, and iron is an abundant, inexpensive, and benign material, and thus, this iron RFB without the membrane is expected to provide a solution to the challenging issues ...



## Mathematical modelling of a membrane-less redox flow battery ...

Experiments under flow are scarce in the literature. Also, most reactors used in RFBs are not valid to test this membraneless-concept due to the zero-gap configuration of filter-press reactors. An example of analysis of the effect of the inter-electrode gap on the cell potential can be found in [11]. Therefore, new reactor designs that allow



## A membrane-free, aqueous/nonaqueous hybrid redox flow battery

Remarkably, a radically new membrane-free flow-reactor was specifically designed to maintain a stable liquid-liquid interphase that allows the battery to operate under ...



## Membraneless Hydrogen-Bromine Flow Batteries for Grid and ...

The hydrogen bromine laminar flow battery (HBLFB) uses abundant, safe, energy dense, and low-cost reactants in an innovative cell architecture that does not require expensive membranes. Using our first generation, proof-of-concept prototype, we demonstrated record power density for a membraneless battery (up to 0.8 W/cm<sup>2</sup> at room temperature).



- ✓ 50KW/100KWH
- ✓ HIGHER POWER OUTPUT IN OFF-GRID MODE
- ✓ CONVENIENT OPERATION & MAINTENANCE
- ✓ PRE-WIRED

## Performance Evaluation of a Scaled-Up Membraneless

This study aimed to scale up a membraneless metal-organic flow battery (1600 cm<sup>2</sup>) using low-cost active materials (zinc and benzoquinone) and to evaluate its performance under various mass

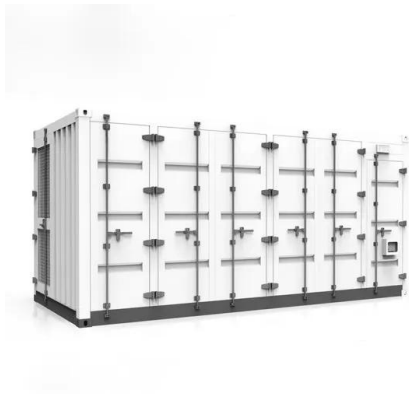


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**Customizable**

## Electrical Model of a Membraneless Micro Redox Flow ...

Abstract: Membraneless micro redox flow batteries are an incipient technology that has

been shown to extend some properties of traditional redox flow batteries. Due to their microfluidic ...



## Performance Evaluation of a Scaled-Up Membraneless Organic ...

This article presents an evaluation of the performance of a membrane-less organic-based flow battery using low-cost active materials, zinc and benzoquinone, which was scaled up to 1600 cm<sup>2</sup>, resulting in one of the largest of its type reported in the literature. The charge-discharge cycling of the battery was compared at different sizes and current densities, and its ...

## (PDF) Membraneless flow battery leveraging flow-through ...

To our knowledge, the only prior report of closed-loop cycling operation of a membraneless cell demonstrated a single cycle at 20% round-trip energy efficiency (using vanadium redox chemistry).<sup>13</sup> The overwhelming majority of membraneless systems utilize co-flowing stream in open channels to separate reactants,<sup>7,11,13,14</sup> yet the 1 results to



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