EUROPEAN COMMISSION

HORIZON 2020 PROGRAMME - TOPIC H2020-LC-BAT-2019
Affordable High-Performance Green Redox Flow Batteries

GRANT AGREEMENT No. 875613

HIGREEW – Deliverable Report

D2.1 – Membranes modification and characterization

The research leading to these results has received funding from the European Union under Grant Agreement no. 875613

Deliverable No.	HIGREEW D2.1	
Related WP	2	
Deliverable Title	Membranes modification and characterization	
Deliverable Date	2021-03-30	
Deliverable Type	REPORT	
Dissemination level	Confidential – member only (CO)	
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Approved by	E. Sanchez (CICe)	2021-04-29
Status	Final	2021-04-29

Disclaimer/ Acknowledgment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875613. The information and views set out in this publication does not necessarily reflect the official opinion of the European Commission. Neither the European Union institutions and bodies nor any person acting on their behalf, may be held responsible for the use which may be made of the information contained therein.

Publishable summary

The HIGREEW project sets out to design, build, and demonstrate a prototype of a new high energy density generation of Aqueous Organic Redox Flow Battery (AORFB) based on a water-soluble low-cost organic electrolyte and featuring low-cost components and long service life.

In this context, membranes are a critical component of RFBs as they largely determine the economic viability of these devices. Membranes are used to prevent cross-mixing of the active species between both compartments, as well as to allow the counterbalance of the ionic species to complete the electric circuit when applying the current. Therefore, a potential membrane candidate to be integrated in this kind of electrochemical systems should exhibit high ionic conductivity, low permeability to active materials, high ion-exchange capacity, as well as chemical and thermal stability. The development or selection of affordable membrane materials has been one of the central goals in the early stages of the HIGREEW project, to safeguard a major economic viability to large scale applications through performing membranes modification. The modification strategies implemented enable upgrading the performance of the battery by preventing and/or decreasing the capacity decay due to crossover phenomena. Furthermore, the mechanical properties were improved, which were attributed to the modification proposed in the project.

This report is a summary of the development and evaluation of membranes/separators for AORFB towards its successful implementation in the HIGREEW RFB according to project objectives. It compiles the tests performed according to protocols defined in WP1. So, the analysis of the fundamental properties as for example ion exchange capacity, conductivity, selectivity, and price, guide us to the selection of the most suitable membranes according to the HIGREEW requirements. Two anionic and cationic ion exchange membranes have been defined as the promising candidates reaching almost all the HIGREEW requirements. Some modification methods have been developed to reduce the high crossover observed. The chemical *in situ* polymerization of pyrrole in CEM and AEM using iron (III) or $Na_2S_2O_8$ as initiator have decreased at least one order of magnitude the permeation of the redox active species without decreasing the conductivity. The characterization of membranes let us to address the use of pyrrole based modified membranes to fulfill the targets of the HIGREEW project.

Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Partner	Partner Full Name
1	CICe	CENTRO DE INVESTIGACION COOPERATIVA DE ENERGIAS ALTERNATIVAS FUNDACION, CIC ENERGIGUNE FUNDAZIOA
2	GAMESA	GAMESA ELECTRIC SOCIEDAD ANONIMA
3	UAM	UNIVERSIDAD AUTONOMA DE MADRID
4	CNRS	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS
5	C-TECH	C-TECH INNOVATION LIMITED
6	HEIGHTS	HEIGHTS (UK) Limited
7	UWB	ZAPADOCESKA UNIVERZITA V PLZNI
8	PFES	PINFLOW ENERGY STORAGE, S.R.O.
9	UNR	UNIRESEARCH BV
10	SGRE	SIEMENS GAMESA RENEWABLE ENERGY

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Appendix A – Quality Assurance

The following questions should be answered by all reviewers (WP Leader, peer reviewer 1, peer reviewer 2 and the technical coordinator) as part of the Quality Assurance Procedure. Questions answered with NO should be motivated. The author will then make an updated version of the Deliverable. When all reviewers have answered all questions with YES, only then the Deliverable can be submitted to the EC.
NOTE: For public documents this Quality Assurance part will be removed before publication.

Question	WP Leader	Peer reviewer 1	Peer reviewer 2	Technical Coordinator
	CICe	CICe	UWB	CICe
Do you accept this deliverable as it is?	Yes	Yes	Yes	Yes
Is the deliverable completely ready (or are any changes required)?	Yes	Yes	Yes	Yes
Does this deliverable correspond to the DoA?	Yes	Yes	Yes	Yes
Is the Deliverable in line with the HIGREEW objectives?	Yes	Yes	Yes	Yes
WP Objectives?	Yes	Yes	Yes	Yes
Task Objectives?	Yes	Yes	Yes	Yes
Is the technical quality sufficient?	Yes	Yes	Yes	Yes