Design of Novel Redox Flow Batteries

Federico Poli, Alessandro Brilloni, Francesca De Giorgio, Francesca Soavi

BETTERY S.r.l., 74016 Massafra (TA), Italy
Alma Mater Studiorum University of Bologna, 40132 Bologna, Italy

E-mail: francesca.degiorgio6@unibo.it
info.bettery@gmail.com

Redox flow batteries (RFBs) are playing a key role for an efficient use of renewable energy sources. One of the main advantages of RFBs is their design flexibility, the possibility of decoupling energy and power and to decrease the amount of inactive components. However, conventional RFBs with aqueous electrolytes exhibit energy density that are 5 times lower than the best marketed Li-ion batteries.

In order to increase energy and power of RFBs and open new markets and applications for these systems, advancements in materials, design and concepts with particular attention to costs, safety and reliability are required. The main strategies are the use of i) light, solid metal anodes like lithium, ii) O_2 (air) based catholytes, iii) organic electrolytes and active species to increase cell voltage above 2 V and to widen temperature operation, iv) semi-solid anolyte and/or catholyte, even featuring powders used in Li-ion batteries, to circumvent the active materials solubility issues of conventional RFBs.

Flow batteries inherently need a smart cell design capable to maximise the power output and minimize the power loss related to the flow. This is particularly important in the case of viscous fluidic electrodes, such as those displaying organic electrolytes and dispersed powders.

Here we report about the evaluation of the pressure drops through laboratory cell prototypes of flow-Li/O_2 cells. The experimental work and the fluid dynamic analyses of the flow frame of the cell provided indications on design strategies to be followed to maximize performance of next generation lithium based RFBs even by low-cost approach like additive manufacturing.

References:

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