Redox-mediated flow batteries in mild electrolytes.

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Abstract

The development of more efficient, safer and accessible batteries is a key point to comply with the objectives set by the European Commission in the Green Deal for the energy transition and the descarbonisation systems. For example, the intermittent energy production from renewable sources requires stationary electrochemical energy storage to match energy production and demand.[1] Among the stationary energy storage systems, redox flow batteries (RFBs) are appealing candidate due to their long cycle life and energy and power independent scalability. The state-of-art of RFBs is the all-vanadium redox flow battery (AVRFB) which provides a competitive solution for stationary applications. Nevertheless, AVRFB presents an important drawback for large-scale implementation: vanadium is considered a critical material. Therefore, the search for alternative chemistries based on organic molecules and non-critical materials elements has been intensified in recent years. However, cycle stability and energy density must be still improved for those emerging organic-based chemistries.[2] Consequently, it is especially relevant to develop new flow battery technologies that can overcome those limitations. A promising and emerging technology is redox-mediated flow battery in which the electroactive species dissolved in the electrolyte are not main contributor to energy storage, but they act as charge carriers shuttling charge between the electrochemical reactor and solid electroactive particles that are confined in the external tanks, which leads to a significant increase in energy density.[3]

The aim of this PhD is to push the boundaries of knowledge in the field of redox-mediated flow batteries, especially at mild pH electrolytes. The following specific objectives are proposed to archive this goal: (1) To develop different electro-analytical techniques for evaluating the fundamental processes, (2) to create a portfolio of soluble redox molecules with a wide range of redox potentials, (3) to study thermodynamic and kinetic aspects of charge transfer between the mediator and electroactive solid particles and (4) to study and improve the cycle stability, and (5) to implement the knowledge in full battery prototypes at lab-bench scale

During the first months of this PhD thesis, objectives (1), (2) and (4) have been pursued, resulting in interesting and promising results for all three objectives.

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References

[1]Páez, T., Martínez-Cuezva, A., Palma, J., Ventosa, E. *ACS Appl. Energy Mater.*, *2* (2019), 8328–8336.
[2]Páez, T., Zhang, F. F., Muñoz, M. Á., Lubian, L., Xi, S., Sanz, R., Wang, Q., Palma, J., Ventosa, E., *Adv. Energy Mater.*, *12* (2020), 1–7.
[3] Sánchez-Díez, E., Ventosa, E., Guarnieri, M., Trovò, A., Flox, C., Marcilla, R., Soavi, F., Mazur, P., Aranzabe, E., & Ferret, R. (2021). *J. Power Sources*, *481*. (2021) XX