Highly concentrated aqueous electrolytes could replace solvents used in batteries

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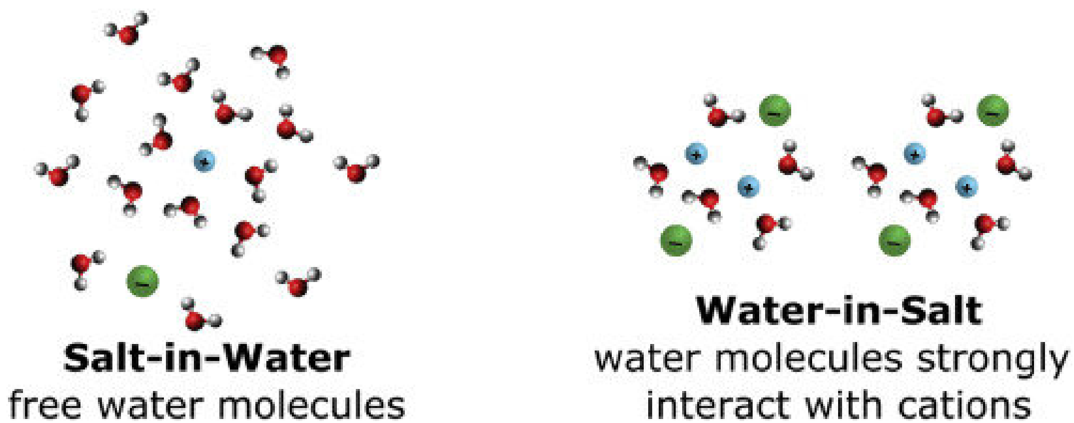

Graphical abstract. Credit: *Current Opinion in Electrochemistry* https://doi.org/10.1016/j.coelec.2020.01.006

Highly concentrated aqueous electrolytes, known as water-in-salt electrolytes, could be an alternative to the organic solvents used in car batteries and other electrochemical devices. They have the advantages of abundance, low cost and nontoxicity, according to the review article "Water-in-salt electrolytes for high voltage aqueous electrochemical energy storage devices," published in the journal *Current Opinion in Electrochemistry* by Vitor Leite Martins and Roberto Manuel Torresi, both of whom are affiliated with the University of São Paulo's Chemistry Institute (IQ-USP) in Brazil.

The study was conducted as part of Martins' postdoctoral research supervised by Torresi and part of the Thematic Project "Optimization of the physicochemical properties of nanostructured materials for applications in molecular recognition, catalysis and energy conversion/storage," for which Torresi is principal investigator. Both projects are supported by FAPESP.

"The term 'water-in-salt electrolytes' refers to solutions constituting a very high concentration of salt in a very small amount of water. The amount of water is just sufficient to dissolve the ions to promote solvation. The system contains no free water, unlike conventional solutions," Torresi told Agência FAPESP.

This is possible only if the salt molecule to be dissolved comprises a large anion and a small cation, Torresi explained. An example is LiTFSI, i.e., lithium bis(trifluoromethane sulfonyl)imide ($CF_3SO_2NLiSO_2CF_3$), whereas NaCI, i.e., sodium chloride or table salt, is of no use, as it has an anion and cation of similar sizes.

"Because there's no free water in this ultraconcentrated solution, electrolytic splitting of water into hydrogen and oxygen becomes far more difficult, so the electrochemical stability of the solution is very high despite the system containing water," he said.

In summary, this innovative technological proposal based on a high concentration of salt in water offers significant advantages over conventional technology using salt dissolved in organic compounds. Nevertheless, the technological use of water-in-salt electrolytes also presents challenges.

"The first is that the solution contains little water and is highly hygroscopic: it tends to absorb moisture from the air, and this changes its water content. The second is that ultraconcentrated aqueous solutions are highly corrosive," Torresi said.

The propensity to absorb ambient moisture is shared with organic solvents and is one of the reasons why conventional batteries have to be shielded, but corrosiveness is a major disadvantage: the organic solvents currently used in lithium batteries do not attack the electrodes, the only metallic components, to a significant extent.

However, according to Torresi, this drawback should not be overestimated. "Corrosion was a major issue for decades. Now, we know how to refine current collectors, and with a few adaptations, it won't be hard to surmount the problem of corrosion in a future aqueous battery," he said.

More information: Vitor L. Martins et al, Water-in-salt electrolytes for high voltage aqueous electrochemical energy storage devices, *Current Opinion in Electrochemistry* (2020). DOI: 10.1016/j.coelec.2020.01.006

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