

Towards Fluorine-Free Ionic Electrolytes Utilizing the Acesulfame Anion

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Rising concerns about operational safety and the environmental impacts of fluorinated compounds prevalently found in electrolytes for lithium and sodium batteries motivates the development of alternative non-flammable, non-volatile, and less hazardous electrolytes. Ionic liquid electrolytes generally exhibit negligible vapor pressure and can have high thermal and electrochemical stability,¹ making them an attractive alternative towards conventional electrolytes. Herein, ionic electrolytes utilizing the acesulfame anion are proposed. The acesulfame anion is a non-fluorinated anion that originates from potassium acesulfame, a toxicologically evaluated tabletop sweetener.² Specifically, N-methoxymethyl-N,N,N-trimethylammonium acesulfame ([N₁₁₁₍₁₀₁₎][ACE]), N-methoxyethyl-N,N,N-trimethylammonium acesulfame ([N₁₁₁₍₂₀₁₎][ACE]), N-ethyl-N-methyl-oxazolidinium acesulfame ([C_{2moxa}][ACE]), N-ethyl-N-methylmorpholinium acesulfame ([C_{2mmor}][ACE]) and N-methyl-N-propylpyrrolidinium acesulfame ([C_{3mpyr}][ACE]) were investigated. These materials were characterized using differential scanning calorimetry, electrochemical impedance spectroscopy, pulsed-field gradient nuclear magnetic resonance, and cyclic voltammetry to assess their thermal, transport, and electrochemical properties. All materials show promising electrochemical windows exceeding 4.90 V (vs Fc/Fc⁺). Of the newly synthesized salts, the [C_{2moxa}][ACE] exhibited the highest ionic conductivity at 3.5 x 10⁻⁴ S cm⁻¹, consistent with ionic diffusivities in the order of 10⁻¹² m² s⁻¹, both at 30 °C. Insights into the structure-property relationships of these new acesulfame-based ILs will aid the development of fluorine-free electrolyte systems.

References

1. Karuppasamy, K.; Theerthagiri, J.; Vikraman, D.; Yim, C. J.; Hussain, S.; Sharma, R.; Maiyalagan, T.; Qin, J.; Kim, H. S. * *Polymers*, **2020**, *12* (4).
2. Administration, U. S. F. D. A. *Food Additives Permitted For Direct Addition To Food For Human Consumption; Acesulfame Potassium*; United States of America, **1988**, *53*, 28379-28383.



Wern Huay Mah is a second-year PhD student at Deakin University, Australia. She is working with Prof. Jenny Pringle and Assoc. Prof. Luke O'Dell to design and understand novel non-fluorinated ionic electrolytes for lithium and sodium batteries. She has completed her Honours degree on solid-supported ionic liquids for wastewater treatment with Mr Faisal Taha and Prof. Cecilia Wilfred in Universiti Teknologi PETRONAS, Malaysia.