Environmental Life Cycle Assessment of Ionogels: Toward Sustainable Electrochemical Energy Storage Devices

Kejie Zhou (1), Jhonny Yunda (1), Hamid Oubaha (2), Jean-François Gohy (3) and Sorin Melinte (1)

(1) ICTEAM, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium

(2) GREEnMat, CESAM Research Unit, Chemistry Department, University of Liège, 4000 Liège, Belgium.

(3) IMCN, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium

The ability to integrate ionic liquids into polymer matrices enables a combination of functionality and adaptability that is difficult to replicate with conventional materials [1]. Despite well-known advantages, the environmental impacts associated with ionogels throughout their lifecycle remain under-researched. Challenges such as the energy-intensive production of ionic liquids and the widespread use of petrochemical-derived polymers highlight the need for a more comprehensive understanding to ensure sustainable development of ionogels. This study addresses this gap by employing Life Cycle Assessment (LCA) to systematically evaluate the environmental performance of prototypical ionogel electrolytes, focusing on raw material extraction, synthesis processes, and potential areas for optimization. Using the ReCiPe 2016 and EF 3.1 impact assessment methods and Monte Carlo simulations, key environmental hotspots were identified, including the significant energy requirements of ionogels synthesis and the reliance on non-renewable feedstocks. This research underscores the critical role of LCA in guiding sustainable innovation in the energy sector, providing actionable insights for researchers, manufacturers, and policymakers to minimize environmental burdens and foster a circular economy.

[1] M. Saatlo, *et al*. Fabrication of solid state supercapacitors using phase change ionogel electrolytes based on 2-hydroxyethyl cellulose and protic ionic liquids with formate, acetate, and propionate as anions. *J. Energy Storage*, **2025**, 108, 115069.