



Next-Generation Energy Storage: The Emerging Role of Gel Polymer Electrolytes

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Energy storage systems have consistently been essential to societal development and technological innovation. Among the most promising approaches to address current energy demands are supercapacitors, also known as ultracapacitors, which are characterized by their high capacitance, elevated power density, and relatively strong energy density. Based on the type of electrode material used, supercapacitors are generally categorized into two main types: pseudo capacitors and electrochemical double-layer capacitors (EDLCs). Another key component of supercapacitors is the electrolyte. Traditional liquid electrolytes often pose challenges such as leakage, safety concerns, and low ionic conductivity. To overcome these issues, polymer electrolytes have garnered growing interest in both research and industry over the past two decades [1-2]. Their applicability goes beyond solid-state lithium or lithium-ion batteries, encompassing a wide range of electrochemical systems such as supercapacitors, electrochromic devices, and sensors.

My research is actively focused on the design and development of advanced polymer electrolytes, particularly those based on ionic liquids, aiming to enhance their structural, electrical, and electrochemical properties [3-5]. Through systematic synthesis, characterization, and performance evaluation, I investigate their role in improving ion transport, stability, and interfacial behavior in electrochemical systems. This work integrates both experimental studies and theoretical insights to better understand material functionality and optimize performance. In my lecture I will therefore highlight the application of these polymer electrolyte systems in energy-related devices, emphasizing their potential in next-generation energy storage technologies.

Keywords: *Polymer electrolytes; Energy storage, Supercapacitors, Batteries*

References:

1. Pooja Mohapatra et.al. *J Power Sources* **626** 235749 (2025).
2. Ali Eftekhari, *Energy Storage Materials* **9** 47-69 (2017).
3. P. Pietryzk Thel et.al. *Journal of Materiomics* **11** 100833 (2025)
4. S. Rawat et.al. *Journal of Material Science: Materials in Electronics* **35** 1643 (2024)
5. Md. Y. Bhat et.al. *Journal of Energy Storage* **130** 117340 (2025)