Supramolecular ionic systems as solid electrolytes: from design to applications in lithium-ion materials

The research on the **transport processes of lithium ions and its' ion complexes in flexible and renewable soft matter systems**, which **undergoes molecular self-assembly phenomena**, opens a **new way of obtaining modern functional materials**. Lithium and its compounds, especially in ionic form, play an **important role in both industrial and personal use**. The most important areas of application of this element include **the glass and ceramics industry, batteries, lubricants, air purification, polymer production, pharmaceutical industry, electronics, and chemical catalysis**. In the times of very dynamic development of the so-called personal electronics and **special care for the environment and human health** in the context of the chemical, pharmaceutical, and transport industries, it is **necessary to develop new forms of materials based on lithium**. Such materials are required to have improved electrical and catalytic properties, or their physical state and low degree of impact on the environment. Designing such materials in the **so-called "Bottom-Up" process used in nanotechnology** allows taking advantage of **the natural self-organization phenomena** occurring at the molecular level to create the structure of the material. **The compounds obtained in this way can be described as organic nanocomposites** because of their matrix made of low molecular weight organic gelators (some of cholesterol and asparagin derivatives) are able to sustain their solid form (ionogels) in temperatures above 100°C, crucial from applicational point of view. As the source of ions in **flexible and renewable solid electrolytes**, the **advanced lithium-based ionic liquids** can be used.

The currently used ionic gels are systems based on polymers, which carries a heavy burden on the natural environment and a costly production process. The use of ionic liquids and low molecular weight gelators to create flexible and renewable solid electrolytes, capable to work in temperatures above 100°C will reduce the negative environmental impacts and increase the application potential. However, to achieve this development stage, **it is necessary to learn and determine the mechanisms of lithium-ion transport in supramolecular structures** and study the thermal properties of the ion systems produced, in particular the phase transitions occurring in them, especially the reversible gel-sol-gel phase transition. The specificity of the intermolecular interactions in the studied systems causing them to be renewable materials allows them **to be used many times as well as subjected to the efficient recycling process**.

The use of advanced and comprehensive experimental techniques in the field of nuclear magnetic resonance spectroscopy (NMR, FFC NMR, eNMR), optical spectroscopy (FT-IR, Raman, UV-Vis), thermal analysis (TGA / DSC) or ion conductivity (TSC) will allow us learning about these systems and knowing it's specificity. The eNMR method is a unique and advanced measurement technique that allows you to directly determine the electrophoretic mobility and effective electric charge of the ions and ion complexes in the tested soft matter systems. Only a few research centers in Europe have the technical capabilities to conduct research using this method. Thanks to close international cooperation with one of the leading research centers in Europe (KTH Royal Institute of Technology in Stockholm, Sweden), advanced eNMR measurements for flexible and renewable solid electrolytes Li-Ion based will be carried out for the first time.

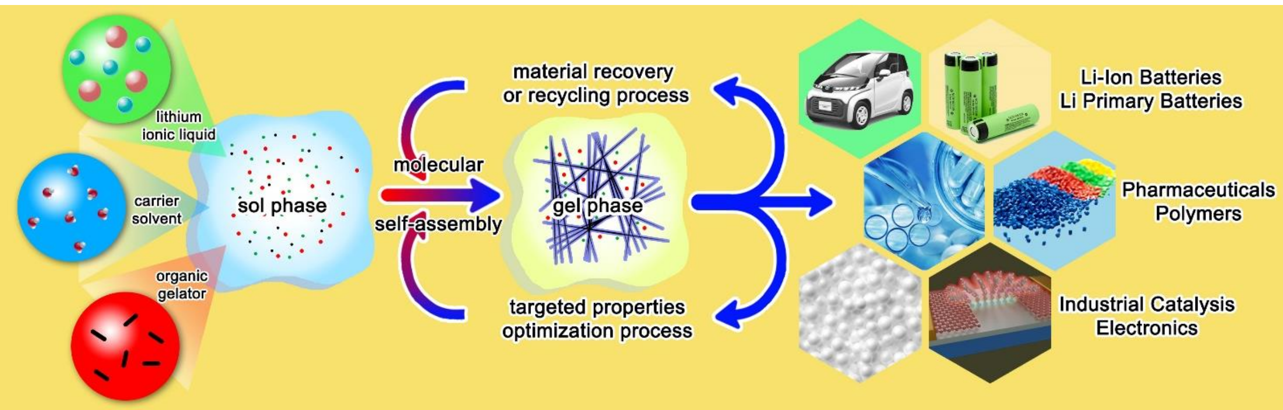

Figure 1 Supramolecular ionic systems as solid electrolytes: from design to applications in lithium-ion materials.