

Modern technology relies heavily on mobile devices and electric vehicles, both of which require lightweight, efficient, and safe energy sources. A key component of such batteries is the electrolyte – a substance that enables lithium ions to move between the electrodes. Commercially used electrolytes in lithium-ion batteries are liquid-based, which makes them flammable and prone to degradation at high temperatures. Therefore, there is an urgent need for safer alternatives, among which polymer electrolytes stand out.

Special attention is being given to gel polymer electrolytes, which represent an intermediate form between liquid and solid electrolytes. They combine the good ionic conductivity typical of liquids with the enhanced mechanical strength and safety associated with solid materials. These gels consist of a polymer matrix saturated with special solvents containing lithium salts. To ensure optimal battery performance, researchers strive to develop materials with high ionic conductivity, thermal and electrochemical stability, and mechanical strength. These characteristics are essential for the safe and long-lasting operation of batteries, especially under high temperatures or during high-current usage.

The properties of gel polymer electrolytes are influenced by various factors, such as the type of polymer used, its concentration and degree of crosslinking, additives that enhance lithium-ion mobility, and the characteristics of the chosen solvent and lithium salt. Developing and optimizing such new electrolytes is a critical area of advancement in electrochemical energy storage. A promising method is *in-situ* synthesis, which involves the direct polymerization and crosslinking of monomers in the presence of a selected solvent and lithium salt. This approach results in mechanically stable, homogeneous structures that conduct ions effectively at room temperature.

The aim of the research is to design new gel electrolytes based on alkyl methacrylates. The properties of the resulting electrolytes will be tailored to specific needs. Their performance parameters (mechanical properties, stability) will be modified by altering the synthesis conditions or by using different solvents, including organic carbonates and ionic liquids. All of this will result in a selection of new electrolytes with specific properties, enabling precise selection for targeted applications. At the same time, we will propose mechanisms responsible for the changes in the properties of these electrolytes.