“Block Copolymers, Methods for Their Preparation, and Uses for Their Application as Anion Exchange Membranes with High Ionic Conductivity”

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Technology description

A technology for the synthesis and modification of block copolymers has been developed which, unlike conventional synthesis routes, does not require the use of metal catalysts or strict stoichiometric conditions, thereby allowing the use of monomers without the need for high purity. The resulting copolymers, based on isatin–dibenzofuran and isatin–para-terphenyl monomeric units, exhibit well-defined structures and can be subsequently modified through nucleophilic substitution reactions, enabling the incorporation of cationic groups for the production of polyelectrolytes.

These polymers exhibit superior chemical, thermal, mechanical, and electrochemical properties, notably high stability at elevated temperatures and under extreme pH conditions, as well as high ionic conductivity. Furthermore, anion exchange membranes (AEMs) fabricated from these materials promote the formation of hydrophobic and hydrophilic phases, thereby optimizing their performance in electrochemical systems.

Applications, benefits and potencial uses of the technology

The technology is applicable to the fabrication of anion exchange membranes for electrochemical systems, electrolyzers for hydrogen production, redox flow batteries, and other energy storage technologies. It can also be used in sensors and electrochemical devices requiring high stability under extreme conditions, as well as in ionic separation processes and water treatment applications.
Its advantages include:

- Simpler and more sustainable synthesis, without the need for metal catalysts.
- Ability to use monomers without stringent purity requirements.
- High mechanical, thermal, and chemical stability.
- High ionic conductivity, exceeding that of comparable existing membranes.
- Controlled formation of hydrophobic and hydrophilic phases.
- Flexibility to obtain polyelectrolytes with different functionalities.

Technology readiness level

The estimated Technology Readiness Level (TRL) of this technology is Level 3, corresponding to the completion of laboratory-scale proof-of-concept studies.

Market information

The primary driver of growth in the ion exchange membrane market is the increasing global demand for cost-effective and rapidly deployable technologies for water purification, electrodialysis, fuel cells, redox flow batteries, and energy storage systems, due to their high ionic selectivity and durability.

Currently, ion exchange membranes dominate the market and are widely used in water treatment, energy storage, redox flow batteries, and chemical processing. This market is projected to reach a valuation of USD 2,060 million by 2032, with a compound annual growth rate (CAGR) of 5.73% between 2024 and 2032.

In 2023, Lanxess AG introduced a new generation of anion exchange membranes with improved selectivity and durability, aimed at both portable and stationary energy systems. If the present technology continues to evolve, it could become a substitute product for Nafion®-based technologies, currently commercialized exclusively by Chemours, which are widely used due to their high conductivity and chemical stability. The global Nafion® market was valued at USD 891.4 million in 2025 and is estimated to reach USD 1,537.1 million by 2035, with a CAGR of 5.6%.