

Objectives

- Basic understanding of ionic liquids
- Describing the different synthetic methods used for the production of ionic liquids as well as their properties will be known through this course.
- Explaining the applications of ionic liquids.

Unit 1: A Basic Introduction to Structure of ionic liquids

Ionic interactions and melting point – effect of ion symmetry, crystal packing, charge delocalization and shielding. Hydrogen bonding. Dications and dianions. Ionicity, ion pairing and ion association. Simulation approaches to structure understanding. Impact of structure on reactivity and application.

Unit 2: Synthetic Methodologies and Characterization Techniques of Ionic Liquids General synthetic methods of ILs – quaternization reaction, anion exchange, metathesis reaction, synthesis through carbonate route. Purification – IL impurities, distillation, sorbents, clean synthesis. Types of ILs – zwitterionic IL, task specific IL, poly-ILs, protic ILs, phosphorous ILs, sulphur ILs. Characterization and analysis- NMR spectroscopy and mass spectrometry of ILs.

Unit 3: Electrochemical Applications of Ionic Liquids

Basic principles of electrochemistry in non aqueous media- potential scanning techniques, electrochemical potential window of ILs and the factors affecting it. Effect of impurities. Choice of working electrode. Redox active ILs. Oxidation and reduction reactions. Application of EIS and XPS to characterise RTILs for electrochemical applications. Energy storage devices – batteries, fuel cells, DSSCs, supercapacitors, actuators, sensors and biosensors.

Unit 4: Ionic Liquids as green solvents and sustainable catalysts

Electrocatalysis, biocatalysis, homogeneous and heterogeneous catalysis. Non solvent applications of ILs in organocatalysis. IL- solvency and intermolecular forces. Liquid-liquid phase equilibrium. Solvent extraction gas solubility and applications. Recovery of expensive catalysts. Application of IL in azeotropic mixture separation and liquid chromatography.

Unit 5: Materialistic and Analytical Applications of Ionic Liquids

Advanced applications of ILs in polymer science. Sample treatments based on ILs. Materials chemistry in ILs. Application of IL in biotechnology. IL as additives. IL as lubricants. Surface interactions of ILs as lubricant additives. Heat transport and storage. ILs in tribology. Thermal fluids ILs in biorefinery. Analytical chemistry- gas, thin layer and HPLC chromatography.

References

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3. Alexander Kokorin, '*ionic liquids : applications and perspectives*', Intech, 2011
4. Chris Hardacre, Vasile Parvulescu, '*Catalysis in Ionic Liquids from catalyst synthesis to Application*', RSC, 2014
5. Olga Kuzmina, Jason P Hallet, '*Application, Purification and Recovery of Ionic Liquids*', Elsevier, 2016.
6. Hong Guo, Patricia Iglesias Victoria, '*chapter Ionic Liquids as High-Performance Lubricants and Lubricant Additives*', Intech, 2021