National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Application of Ammonium and Imidazolium-Based Ionic Liquids: An Optical Spectroscopy-Based Analysis of Protein Stability and Conformation
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Venue	: Seminar Room (Chemistry Department)
Date and Time	: 30 Jun 2025 (04:00 PM)
Abstract	: Ionic liquids (ILs) have emerged as promising alternatives to conventional solvents due to their tunable physicochemical properties, biocompatibility, and ability to stabilize sensitive biomolecules. This study presents a comparative analysis of how different ammonium- and imidazolium-based ILs, including mono- and dicationic variants, interact with a model cytoplasmic protein. Spectroscopic techniques were employed to monitor alterations in protein microenvironment, secondary structure, and functionality upon exposure to ILs of varying chain lengths and structural features. Steady state and synchronous fluorescence analyses revealed concentration-dependent effects, with initial increases in fluorescence intensity at low IL concentrations followed by quenching at higher concentrations in Monocationic ammonium ILs. This behavior indicated altered solvent accessibility and changes in the polarity around aromatic residues, particularly tryptophan. Temperature-dependent studies showed that quenching mechanisms varied: monocationic ILs exhibited dynamic quenching, while dicationic and surface-binding ILs showed static behavior. Circular dichroism spectroscopy confirmed that the protein&rsquos &beta-sheet-dominant secondary structure remained largely intact across all ILs, with minimal disruption at higher concentrations. Thermodynamic analyses highlighted that van der Waals forces, electrostatic attractions, and hydrophobic interactions are key drivers of IL&ndashprotein association, with the nature of interaction depending on the IL structure. ANS-binding assays suggested that ILs can modulate surface hydrophobicity, and molecular docking supported experimental findings by identifying residue-specific interaction patterns. Overall, the study demonstrates that IL&ndashprotein interactions are highly dependent on IL architecture and concentration, and that certain ILs can stabilize proteins without compromising structural or functional integrity. These insights pave the way for rational IL design in protein preservation, formulation, and biotechnological applications.