National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title : Cu(I)-Induced G-Quadruplexes: Responsive Supramolecular Polymers with Thermal Aqueous Phase Transitions
Speaker : Nihar Sahu (Rollno : 520cy1002)
Supervisor : Bimalendu Adhikari
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Abstract : G-quadruplexes, important non-canonical DNA structures found in telomeres, are typically stabilized by Hoogsteen hydrogen bonding, &pi&ndash&pi stacking, and metal coordination but remain inherently labile. In this thesis, in-situ generated Cu(I) was employed for the first time to form exceptionally stable guanosine(G)-based quadruplexes. The G4.Cu+ quadruplex undergo rapid supramolecular polymerization with slow gelation, yielding robust polymers and gels resistant to heat and dilution. Their enhanced stability compared to K+-stabilized systems arises from strong Cu+&ndashguanine coordination and metallophilic Cu+-Cu+ interactions. Beyond stability, the systems display stimuli-responsive behavior: below a critical temperature, slow dehydration accelerates gelation, while above it, faster dehydration drives precipitation, as confirmed using kosmotropic anions. Furthermore, a redox-reversible G-quadruplex gel was demonstrated for the first time via the Cu+/Cu2+ couple, highlighting adaptability through reversible assembly and disassembly. Next, we studied Guanosine monophosphate, the nucleotide form of guanosine bearing a phosphate group, moving beyond the nucleoside G. The phosphate moiety carries a negative charge at acidic pH and a double negative charge at basic pH, which strongly influences selfassembly. While the monoanionic form supports gelation, the dianionic form is generally restricted to G-quadruplex formation due to electrostatic repulsion. Interestingly, Cu+- induced GMP-quadruplexes showed distinct conformations depending on temperature and pH. Heating enhanced polymerization at acidic pH and promoted crosslinking. Guided by this, we tested gelation under basic conditions and, for the first time, observed an GMPbased G-quadruplex gel at elevated temperature&mdashmade possible by the stability of the Cu+-induced structure. Finally, a Cu2+-mediated G-gelation pathway was uncovered, where higher ion concentration and elevated temperature yielded dimeric assemblies that could be transformed into Cu(I)-stabilized G-quadruplexes upon reduction by ascorbic acid. These findings not only establish Cu(I)-induced G-quadruplexes as robust supramolecular platforms but also open avenues for their extension to DNA/RNA oligomers, tunable UCST LCST phase-transition, redox-driven supramolecular plastics. Together, they highlight the potential of G&ndashCu(I) supramolecular polymers in creating intelligent, adaptable, and environmentally friendly soft materials.