Summer School: Molecules to Materials: Monomer Design and Advanced Polymer Synthesis

Instructors:

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Duration: 6 Days (Tentative dates: 9-15 June 2026)

Morning (Lecture): 10 am – 12:30 pm

Afternoon (Experiment): 1:30 pm – 4:30 pm

1. Preamble:

Polymer science has advanced greatly over the last few decades, shifting from traditional bulk materials to highly engineered systems with precise structural and functional control. Modern applications in areas such as energy storage, electronics, healthcare, and sustainable materials increasingly rely on the ability to design polymers at the molecular level. In this context, monomer design has become a key focus, allowing the attachment of specific functionalities that determine the physical, chemical, and electronic properties of the final materials. At the same time, progress in controlled and living polymerization methods has enabled the production of polymers with predictable molecular weights, architectures, and functionalities. These advancements have transformed polymer chemistry into a discipline closely intersecting with materials science, nanotechnology, and industrial innovation.

Despite these advancements, there is still a gap in traditional curricula: polymer chemistry is often taught primarily through theory, with limited focus on modern experimental techniques and research-based problem-solving. This proposed summer school seeks to fill that gap by offering an integrated, hands-on learning experience that links fundamental principles with modern practices in polymer synthesis. The course is designed to lead participants through the entire process, from monomer synthesis and design to polymerization using advanced techniques, culminating in characterization and property analysis. By combining structured lectures with laboratory sessions and a mini-project, the program aims to help students build both conceptual understanding and practical skills. Moreover, the focus on data analysis and report submission will foster a research mindset, preparing participants for future careers in academia or industry.

2. Eligibility Criteria:

- Senior undergraduate students (3rd/4th year B.Sc./B.S./B.Tech.)
- Postgraduate students (M.Sc./M.S.) in Chemistry or related disciplines
- PhD students in Chemistry, Materials Science, or allied areas
- Basic knowledge of organic chemistry is expected

3. Selection Criteria:

- Academic performance (transcripts/grades)
- Statement of purpose indicating interest in polymer/materials chemistry
- Recommendation letters (optional)

4. Course content:

Day 1 – Introduction to Polymer Science and Thermal Polymerization

Morning (Lecture): Polymer classification, molecular weight, radical polymerization basics etc.; Radical polymerization & inhibitors

Afternoon (Experiment/Lab Orientation): Safety, glassware, and other technical demonstrations; Thermal polymerization of styrene and MMA

Day 2 – Initiator-Controlled Polymerization

Morning (Lecture): Kinetics & degree of polymerization

Afternoon (Experiment): AIBN-initiated polymerization

Day 3 – ATRP

Morning (Lecture): Living polymerization & ATRP mechanism

Afternoon (Experiment): ATRP of PS/PMMA

Day 4 – Copolymerization

Morning (Lecture): Copolymer composition and reactivity ratios

Afternoon (Experiment): Styrene–MMA copolymerization

Day 5 – Functional Monomer Design and Polymerization

Morning (Lecture): Design principles of functional monomers, NHS ester chemistry, structure-reactivity relationships, Polymerization strategies for functional monomers (ATRP compatibility, side reactions)

Afternoon (Experiment): Synthesis of monomer **A** (activated NHS ester) and purification; Polymerization of monomer **A,** and product isolation

Day 6 – Mini Project

Project options: Temperature vs MW, Initiator vs DP, Copolymer composition

Activities: Execution, data collection, and report submission