

Photopolymerizations Center

The University of Iowa and the University of Colorado

Photopolymerizations offer tremendous advantages over traditional thermal processing methods, including low energy requirements, spatial and temporal control of initiation, and high polymerization rates

*A National Science
Foundation
Industry/University
Cooperative
Research Center
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Center Mission and Rationale

The primary mission of the Photopolymerizations Center is to advance the fundamental understanding of the kinetics and mechanisms of photopolymerizations. This mission is advanced through the unique opportunity for active collaborations among industrial and academic investigators who are both exploring cutting-edge research on photopolymerization processes and developing novel applications based upon the unique set of advantages offered by photopolymerizations. These advantages have led to tremendous growth in applications of photopolymerizations in areas such as solvent-free processing, biomedical materials, and high-technology devices. However, much of this growth is occurring without a fundamental understanding of the underlying photochemical processes. Hence, there is a critical need to establish an active dialogue between academic and industrial researchers. The objectives of the Center are: (1) to advance the fundamental understanding of the kinetics and mechanisms of photopolymerizations; (2) to establish a venue for active discussions and collaborations among industrial and academic researchers; (3) to explore high-risk, cutting-edge research on photopolymerization processes that could lead to technological innovations; and (4) to promote and/or develop novel applications that exploit the unique set of advantages offered by photopolymerizations.

Research Program

The faculty of the Center are conducting a comprehensive study of the kinetics and mechanisms of photopolymerizations and their impact on the structure and properties of photopolymerized materials. The kinetic and mechanistic contributions to photopolymerizations

play a critical role in determining the macroscopic structure and material properties of the product. The Center unites a productive research team with expertise that spans a variety of scientific arenas, including fundamental photophysical and photochemical processes, polymerization reaction engineering, spectroscopic characterization methods, network formation modeling, and advanced high resolution microscopies. Both radical and cationic photopolymerizations are being examined with state-of-the-art experimental techniques to elucidate the complex chemical and physical mechanisms that control the initiation, propagation, and termination of the active centers. These fundamental studies are helping to establish the underlying reaction-structure-property relationships that will lead to the development of new applications and to profound improvements in existing photopolymerization processes. Research topics that are currently under investigation include:

- Fundamental Characterization of Three-Component Initiator Systems
- Kinetics Studies of Cationic Photopolymerizations
- Kinetic Studies of Hybrid Cationic/Radical Photopolymerizations
- Characterization of Volatile Components Emitted from UV-Cured Coatings
- Structural Evolution in Photocrosslinked Films/Living Radical Photopolymerizations
- Modeling of Free Radical Photopolymerization Kinetics
- Fundamental Relationships Between Monomer Structure and Reactivity
- Characterization of Crosslinked *Degradable* Networks
- Photopolymerizations of Composites/Impact of Oxygen on Photopolymerization Kinetics and Polymer Structure
- Fundamental Studies of Thiol/Ene Photopolymerizations



A view of the Iowa Advanced Technology Laboratories, a state-of-the-art research facility that houses the Photopolymerizations Center at The University of Iowa.



A view of the University of Colorado's Engineering Center, where the Photopolymerizations Center activities are based, with the Rocky Mountains in the background.

Special Center Activities

The Center is working to fill the need for education in the fundamentals and applications of photopolymerizations by pursuing a variety of innovative educational programs targeted to undergraduate students, graduate students, and industrial scientists. Specific goals of these programs are: (1) to engage undergraduate and graduate researchers in cutting-edge research experiences guided by a multidisciplinary academic and industrial leadership team; (2) to develop novel experiments on photopolymerization science and engineering that can be integrated into existing undergraduate courses; (3) to create a new dual-level course entitled *Fundamentals and Applications of Photopolymerization* that includes classroom lessons from academic and industrial experts as well as laboratory and hands-on homework experiences; and (4) to design and implement a new, web-based photopolymerization course, targeted to graduate students and industrial scientists and engineers, that exploits the educational advantages of the multimedia educational environment. The curriculum development activities will build from both the Center research and the perspective provided by the industrial members of the Center.

Facilities

The Photopolymerizations Center is jointly housed at the University of Colorado and the University of Iowa. At the University of Iowa, activities span numerous departments including Chemical and

Biochemical Engineering, Chemistry, and Operative Dentistry. At the University of Colorado, activities are focused in the Department of Chemical Engineering and the School of Dentistry. Thus, this Center unites a productive team from numerous academic departments with expertise and facilities that span a variety of scientific and educational arenas.

The extensive research facilities available to the Center faculty provide the equipment and instrumentation necessary to thoroughly characterize photopolymerization systems on the molecular, microscopic, and macroscopic levels. Center researchers use these facilities to understand the fundamental photophysical and photochemical processes involved in the photoinitiation reaction, to characterize the high-speed propagation and termination kinetics that lead to the polymer structure, and to evaluate the material properties through the course of the photopolymerization reaction. Within the Center, both radical and cationic photopolymerizations are studied with state-of-the-art experimental techniques to elucidate the complex chemical and physical mechanisms that control the initiation, propagation, and termination of the active centers. The broad array of facilities available to the Center provides the necessary tools to allow a fundamental understanding of these complex, yet ubiquitous, polymerizations.

Center Headquarters

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