

Polymerization processes are widely used for the production of various materials, making them one of the key technologies in modern prototyping. Specifically, photopolymerization is the foundation of many advanced 3D printing methods, enabling the creation of precise and functional prototypes and components in industry. By utilizing light-curing resins, the 3D printing process offers a unique opportunity to produce structures with complex geometries that are difficult to achieve with traditional manufacturing methods.

This project focuses on the development of innovative hybrid resins for free radical-induced cationic photopolymerization. The use of radical photoinitiators as sensitizers in the printing process with cationic monomers such as oxetanes or glycidyl ethers will enable the production of materials with diversified properties compared to the commonly used acrylate and methacrylate monomers. Currently, cationic initiating systems are not used in 3D printing due to the lack of commercially available ionic salts that are active in the visible spectrum. Thus, they are not compatible with light sources commonly used in available 3D printers, which are LEDs emitting at 405 nm.

The advantage of the new photoinitiators compared to those currently available will be their much higher long-wavelength light absorption, making them more compatible with the light emission of 3D printer light sources, which will facilitate and accelerate the printing process. Cationic polymerization offers several advantages over conventional radical polymerization, including reduced material shrinkage and the absence of oxygen inhibition. The addition of visible-light absorbing radical photoinitiators will allow for free radical-induced cationic photopolymerization, resulting in materials with improved properties, such as greater transparency, reduced wear resistance, and higher 3D printing resolution.

The developed photoinitiators will be used in the 3D printing of innovative biosensory models for aerodynamic testing with built-in pressure and temperature sensor systems. The use of the developed photoinitiating systems will enable the production of high-resolution prints with high pressure channel permeability. This solution will significantly increase the spatial resolution of pressure and temperature distribution maps compared to traditional techniques, as well as enable precise aerodynamic tests for very slim models, where manual sensor assembly is not feasible. This will contribute to better design of aerodynamic objects (e.g., wind turbines, transportation machinery), resulting in significant economic benefits (e.g., reduced fuel consumption, improved wind turbine performance), as well as improved safety for users of such objects.

The implementation of this project will contribute to further development of 3D printing and photopolymerization technologies, as well as the creation of new materials and production methods that will have wide applications in various modeling fields, from the automotive industry to aerospace and military prototyping applications.

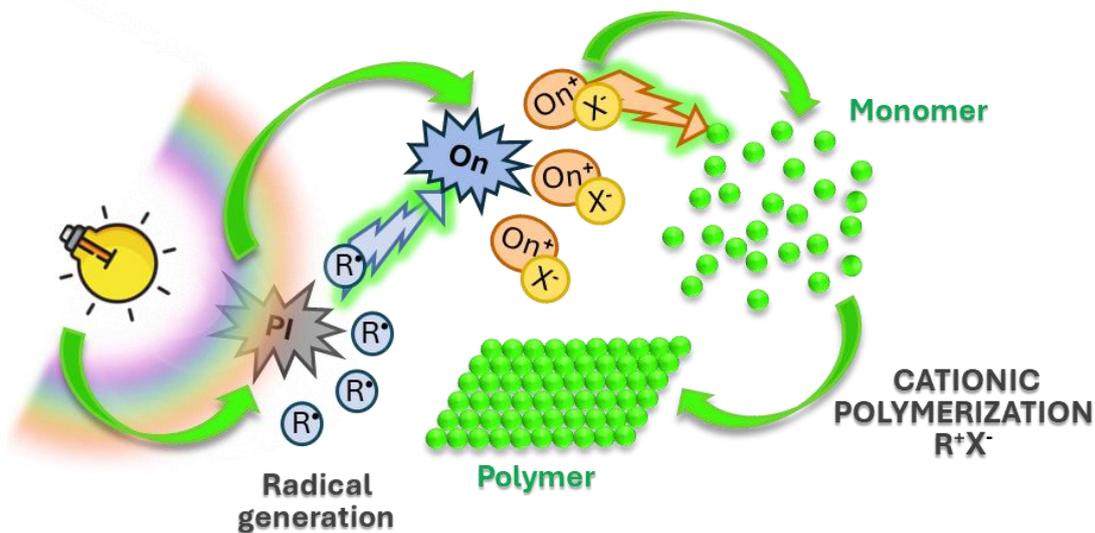


Figure 1. Diagram illustrating the mechanism of action of new photocurable resins via free radical-induced cationic photopolymerization