Radiation-Induced Changes in Mechanical Properties of Cellulose-Based Materials for Grafted Polymer Applications

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Purpose

Cellulose is the most abundant naturally occurring polymer and is widely studied due to its inherent advantages, including high biodegradability, biocompatibility, and renewability. In numerous studies, cellulose and its derivatives have been modified using radiation-induced grafting techniques. However, native cellulose exhibits high crystallinity and limited functionality due to its uniform chemical structure. Therefore, cellulose derivatives and regenerated cellulose have attracted increasing interest because of their improved material properties.

This study investigates the effects of electron beam irradiation on the mechanical properties of cellulose-based materials to evaluate their suitability as backbone substrates for grafted polymer systems. Specifically, the objective was to examine how increasing irradiation doses influence the tensile strength of cellulose acetate and regenerated cellulose (cellophane), in dry conditions. By exposing the samples to carefully selected electron beam doses, the resulting changes in tensile strength were systematically analyzed as a function of irradiation dose.

Methods

The samples were cut into dog bone-shaped specimens using a custom mold, following the general geometry of ASTM D638 sub-size specimens. The specimens were then irradiated with an electron beam at doses of 10, 20, 40, 60, 80, and 100 kGy under dry condition. Tensile testing was subsequently performed using a universal testing machine, where a controlled and uniformly increasing tensile load was applied to both irradiated and untreated specimens.

Results

The experiment is currently in progress. The results will be presented upon completion of the experimentation.

Conclusion

Conclusions will be drawn once the experimentation is complete.

Relevance to CIRMS

This study forms part of the doctoral research of the primary author and focuses on irradiation-induced changes in the mechanical properties of cellulose acetate and cellophane. These materials will be used as backbone substrates for the synthesis of grafted polymers intended for CO_2 capture applications. The study aligns directly with the CIRMS mission through its objective of employing irradiation techniques to achieve grafting while minimizing damage to the polymer backbone.
The primary author aims to pursue an academic career with a research focus on the diverse applications of ionizing radiation across multiple fields, including environmental chemistry and polymer science.