

584g Synthesis of Poly(Butyl Acrylate)-G-Starch and Poly(Styrene)-G-Starch by Emulsion Photopolymerization to Produce Biodegradable Copolymers from Corn Starch

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Polymers have been synthesized primarily from petroleum-based products, such as styrene, acrylates, and methacrylates. Because of rising petroleum costs and increased environmental awareness, focus has shifted towards using renewable resources to create polymers. Starch is an inexpensive, natural polymer that may be modified with petroleum-based monomers to form useful copolymers. Starch is also hydrodegradable and biodegradable, which make copolymers of starch and synthetic monomers environmentally friendly.

In this research, emulsion polymerizations were initiated with a water-soluble photoinitiator, instead of typical thermal initiators. The emulsions studied include formulations of sodium dodecylbenzene sulfate, water, butyl acrylate or styrene, starch, Uvinul® 3048, and sodium bicarbonate. Emulsion polymerization is advantageous because it is water based, low temperatures are easily maintained, and high molecular weight polymers can be formed without large increases in viscosity.

Photopolymerization is advantageous because it can be spatially and temporally controlled, is rapid, polymerization can be achieved at ambient temperature, and is energy efficient. This is a more versatile method for grafting synthetic monomers to starch than previous thermal pathways because initiation is not related to temperature and the active centers are located in the micelles of the emulsion after formation on starch during pre-illumination. These characteristics control side reactions and allow for high molecular weight grafts to be formed during this process.

The goal of this research is to determine if pre-illumination of starch, water, and photoinitiator produces more grafting of polymer to starch than illumination of all emulsion components at once. This was measured by calculating a grafting efficiency, which is the amount of grafted polymer divided by the total polymer weight. The grafting efficiency was measured using gravimetric methods and verified by Raman spectroscopy using a non-contact optic with 150- μm spot size. Raman spectroscopy allows for a large area to be analyzed quickly, and a calibration curve was used to determine the percent polystyrene or poly (butyl acrylate) by weight that remained in the sample after extraction of non-grafted polymer. When all components of the emulsion are irradiated simultaneously, almost no grafting occurs. If starch, water, and photoinitiator are irradiated before the surfactant, monomer, and other components of the emulsion are added, the grafting percent is increased. In initial studies, the grafting efficiency has been shown to increase as the pre-illumination time is increased, which indicates that more chains are grafted to the starch as pre-illumination time is increased.

The efficiency and ease of this technique enable grafting a number of synthetic monomers to starch without resorting to high temperatures and/or pressures. These copolymers may be used for many different applications because the mechanical properties may be varied by changing the monomer grafted or a combination of monomers added. Potential applications for these copolymers include sizing materials for recycled paper processing, disposable plates, and biodegradable plastics.