Sustainable Leather Alternatives: The Effect of Zinc Oxide and Microcrystalline Cellulose on Mechanical Properties and UV-Blocking of Sodium Alginate- and Gelatin-Based Biomaterials

Jansen, Erin (School: Patriot High School)

Negative environmental and health-related impacts of real and synthetic leather production have prompted interest in biobased alternatives that maintain functional performance while reducing reliance on hazardous, resource-depleting processing methods. This study investigated whether sodium alginate- and gelatin-based biomaterials could be engineered to approximate the mechanical properties of leather and its synthetic alternatives through additive reinforcement. This research examined how zinc oxide (ZnO) and microcrystalline cellulose (MCC), incorporated at varying concentrations, affect tensile strength, wear resistance, flexural rigidity, and ultraviolet light-blocking. Biomaterials were fabricated using sodium alginate or beef gelatin plasticized with glycerin and reinforced with either ZnO or MCC. Material performance was evaluated using tensile, wear, stiffness, and UV light intensity testing and compared to leather, polyurethane leather, and marine vinyl. Unmodified biomaterials exhibited low tensile strength and limited UV blocking, demonstrating the need for reinforcement. ZnO significantly improved tensile strength and completely blocked UV light in both base biomaterials, with optimal performance at intermediate concentration. MCC produced concentration-dependent increases in base biomaterial flexural rigidity, but reduced wear resistance. Results of this study demonstrate that sodium alginate- and gelatin-based biomaterials can be tuned to achieve application-specific mechanical and functional properties through additive selection and concentration control. This research supports the potential of biobased materials as sustainable alternatives to conventional real and synthetic leather products, mitigating negative environmental impact and health risks.

Awards Won:
Fourth Award of $600