

# Production and Characterization of Polyurethane-Based Artificial Leather Using Release Paper Technology

Siddhi Shukla\*, Rajesh Kumar Kaushal, Vikas Vishwakarma

*Department of Chemical Engineering, IPS Academy, Indore, India.*

Received: 15<sup>th</sup> April 2026; Revised: 22<sup>th</sup> April 2026; Accepted: 23<sup>th</sup> April 2026  
Available online: 27<sup>th</sup> April 2026; Published regularly: December 2026



## Abstract

Natural leather production involves animal use and chemical-intensive tanning processes, creating environmental and ethical concerns. Therefore, developing sustainable alternatives is important for modern footwear, garment, furniture, and automotive industries. This study aimed to prepare polyurethane (PU)-based synthetic leather using release paper technology and evaluate its physical and mechanical properties. PU solution was coated onto textured release paper, followed by drying, curing, and lamination with textile fabric to obtain the final leather-like material. The prepared product successfully reproduced a leather-like surface texture. Mechanical testing revealed tensile strength values of 11–18 MPa and elongation at break of 180–300%, indicating adequate strength, flexibility, and durability for practical applications. The process also offers advantages such as lower volatile organic compound emissions, avoidance of chromium-based tanning chemicals, and potential reuse of release paper. These findings demonstrate that PU-based synthetic leather produced by this method is a promising alternative to conventional natural leather. The developed material demonstrates potential for sustainable industrial synthetic leather production.

Copyright © 2026 by Authors, Published by Universitas Diponegoro and BCREC Publishing Group. This is an open access article under the CC BY-SA License (<https://creativecommons.org/licenses/by-sa/4.0>).

**Keywords:** Polyurethane; synthetic leather; release paper; coating technology; sustainability

**How to Cite:** Shukla, S., Kaushal, R. K., Vishwakarma, V. (2026). Production and Characterization of Polyurethane-Based Artificial Leather Using Release Paper Technology. *Journal of Chemical Engineering Research Progress*, 3 (2), 174-180 (doi: 10.9767/jcerp.20707)

**Permalink/DOI:** <https://doi.org/10.9767/jcerp.20707>

## 1. Introduction

Natural leather has traditionally been used in footwear, garments, bags, upholstery, and automotive interiors because of its strength, durability, and premium appearance. However, conventional leather production is associated with environmental and ethical concerns due to animal-derived raw materials and the use of chemical-intensive tanning processes. Leather processing also consumes large quantities of water and generates waste containing chromium salts, dyes, and other pollutants. Therefore, the development of sustainable and cruelty-free alternatives has become increasingly important for modern industries [1,2].

Polyurethane (PU)-based synthetic leather has emerged as one of the most promising substitutes for natural leather because of its softness, flexibility, abrasion resistance, and leather-like surface characteristics. Compared with PVC-based synthetic leather, PU materials generally offer better comfort, lower toxicity, and improved mechanical properties. Due to these advantages, PU artificial leather is widely used in shoes, garments, furniture, luggage, sports goods, and automotive interiors [3,4]. Previous studies have reported significant progress in PU chemistry and synthetic leather manufacturing. Sur *et al.* [5] investigated DMF-based polyurethane systems for wet-type artificial leather and reported satisfactory mechanical properties. Tian [6] reviewed functional polyurethane materials and highlighted their growing applications in leather manufacture.

\* Corresponding Author.

Email: [siddhishukla844@gmail.com](mailto:siddhishukla844@gmail.com) (S. Shukla)

Researchers [7] summarized recent advances in greener polyurethane systems, including waterborne PU and low-VOC technologies. Other researchers [8] discussed porous surface coatings for polyurethane synthetic leather and emphasized the importance of surface engineering for performance improvement.

Despite these developments, many reported studies mainly focus on polymer synthesis, eco-friendly raw materials, or coating chemistry, while comparatively fewer studies describe the practical production sequence of PU artificial leather using release paper technology and its influence on final surface texture, adhesion, durability, and mechanical properties. In addition, limited studies present industrially relevant data combining manufacturing steps with final product performance [8,9].

Therefore, the present study aims to investigate the production of polyurethane-based artificial leather using release paper technology and evaluate its physical and mechanical characteristics. Special attention is given to surface finish, tensile strength, elongation at break, water resistance, and suitability for industrial applications. This work provides practical insight into an efficient manufacturing route for producing high-quality PU synthetic leather as an alternative to conventional natural leather.

## **2. Materials and Method**

### **2.1. Materials**

Polyurethane (PU) resin was used as the primary coating polymer for the preparation of artificial leather because of its excellent flexibility, abrasion resistance, adhesion strength, and film-forming properties. Textured silicone-coated release paper was used as a temporary carrier substrate to transfer the desired grain pattern and surface finish to the polyurethane layer during processing. Polyester/cotton blended textile fabric was used as the backing substrate to improve tear resistance, dimensional stability, and mechanical strength of the final composite material. Pigments, fillers, and processing additives were incorporated to control colour, viscosity, coating uniformity, and overall performance of the PU formulation [6,7].

### **2.2. Preparation of PU Artificial Leather**

The polyurethane coating formulation was prepared by mixing PU resin with pigments, fillers, and additives under continuous mechanical stirring for approximately 20–30 min until a homogeneous mixture was obtained. The prepared formulation was then uniformly coated

onto the textured surface of release paper using a coating applicator with an approximate wet thickness of 0.20–0.35 mm.

The coated sheet was dried in a hot-air oven at 80–100 °C for 5–10 min to remove solvent and partially solidify the coating layer. Thereafter, curing was carried out at 130–150 °C for 3–5 min to promote polymer crosslinking and strengthen the polyurethane film. Such thermal treatment is commonly employed in PU coating systems to obtain stable film formation and improved durability [5,8].

After partial curing, polyester/cotton backing fabric was laminated onto the semi-cured PU layer under an applied pressure of approximately 0.3–0.5 MPa. Final curing was then performed for 2–3 min to ensure complete adhesion between the polyurethane layer and fabric substrate. After cooling, the release paper was peeled off carefully to obtain the finished polyurethane artificial leather sheet with the transferred surface texture [3,8].

### **2.3. Sample Conditioning**

Before testing, all developed samples were conditioned at room temperature ( $25 \pm 2$  °C) for 24 h to minimize the effect of environmental moisture and temperature variations on measured properties. Conditioning of polymer-coated materials prior to testing is commonly recommended for obtaining reproducible results.

### **2.4. Testing Methods**

Mechanical and physical properties of the prepared artificial leather samples were evaluated using standard testing methods. Tensile strength and elongation at break were measured using a Universal Testing Machine (UTM) according to relevant ASTM/ISO procedures. Test specimens of approximately 100 mm × 25 mm were used.

Peel adhesion strength was determined using a 180° peel test to evaluate bonding strength between the polyurethane coating and textile backing layer. Abrasion resistance was measured using a Martindale or Taber abrasion tester to determine surface wear durability. Water absorption was determined by immersing samples in distilled water for 24 h and measuring percentage weight gain. Sample thickness was measured using a digital micrometer. All tests were conducted in triplicate, and average values were reported [10–12].

### **2.5. Process Parameters**

The principal processing variables considered during the study included coating thickness, drying temperature, curing

temperature, lamination pressure, and release paper texture. PU coating thickness was maintained within 0.15–0.40 mm to achieve a balance between flexibility and strength. Drying temperature was controlled between 80–120 °C to facilitate solvent evaporation, while curing temperature was maintained within 120–160 °C to ensure complete polymer network formation. Lamination pressure was adjusted between 0.2–0.6 MPa for effective bonding with the textile backing. Surface finish of the final product was controlled by selecting smooth, matte, or embossed release paper textures [7,8]. The processing parameters used during preparation are summarized in Table 1, while the standard test methods adopted in this study are presented in Table 2.

### 3. Results and Discussion

#### 3.1. Relation of Findings to Research Objective

The main objective of this study was to develop polyurethane-based artificial leather using release paper technology and evaluate its performance characteristics. The findings demonstrate that the adopted production route effectively generated synthetic leather with satisfactory surface texture, mechanical strength, flexibility, and moisture resistance. Therefore, the study objective was successfully achieved.

#### 3.2. Surface Quality and Texture Transfer

The developed samples exhibited smooth and uniform surfaces without visible cracks, bubbles, or coating defects. This indicates that the coating viscosity, drying conditions, and curing

parameters were properly controlled during processing. The embossed release paper accurately transferred grain patterns to the PU surface, producing a leather-like appearance.

Similar observations were reported by [8], who stated that release paper technology improves texture replication and surface finish quality in PU synthetic leather production. The present findings confirm that release paper selection is a critical parameter for final product aesthetics. The surface characteristics and visual observations of developed samples are shown in Table 3.

#### 3.3. Mechanical Strength and Flexibility

The tensile strength of 11–18 MPa indicates adequate load-bearing capacity for industrial applications. This performance can be attributed to strong interfacial bonding between the polyurethane coating and textile backing fabric. The fabric substrate helps distribute applied stress, while the PU layer provides elasticity and toughness.

Elongation at break values of 180–300% demonstrate excellent flexibility of the developed material. High elongation is desirable in footwear, garments, and upholstery applications where repeated bending occurs [13,14]. Comparable values were reported by [7] for commercial PU synthetic leather materials.

#### 3.4. Peel Adhesion and Durability

The peel adhesion strength of approximately 18 N/cm confirms strong bonding between layers. Good adhesion was likely achieved because lamination was carried out at appropriate

Table 1. Processing parameters used for PU leather preparation (Adapted from [7,8]).

Parameter	Typical Range	Purpose
PU Coating Thickness	0.15 – 0.40 mm	Controls strength and flexibility
Drying Temperature	80 – 120 °C	Solvent removal
Curing Temperature	120 – 160 °C	Polymer network formation
Lamination Pressure	0.2 – 0.6 MPa	Improves bonding
Line Speed	5 – 40 m/min	Coating uniformity
Release Paper Texture	Smooth / Matte / Embossed	Surface finish

Table 2. Tests methods for PU artificial leather (Adapted from [7,12]).





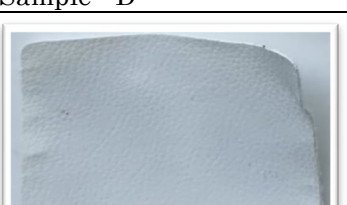
Test Parameter	Instrument	Standard Methods
Tensile Strength	Universal Testing Machine	ASTM D751 / ISO 3376
Elongation	Universal Testing Machine	ISO 3376
Peel Adhesion	180° Peel Test	ISO 8510-2
Abrasion Resistance	Martindale / Taber	ISO 12947
Water Absorption	Immersion Test	ASTM D6015
Thickness	Digital Micrometer	Internal method

pressure and curing temperature, allowing proper interpenetration between the polymer layer and textile substrate. Abrasion resistance of 1250 cycles indicates satisfactory durability under repeated frictional forces. This result is important for footwear and furniture applications where surface wear resistance is essential.

### 3.5. Water Resistance

Low water absorption (~0.4%) suggests that the developed PU coating formed a dense and continuous barrier structure. Such low moisture uptake improves dimensional stability and long-term durability [15]. Similar moisture resistance has been reported in polyurethane-coated

Table 3. Surface characteristics of developed samples.

Samples ID	Color	Surface Structure	Finish Type	Observation (Application)
 Sample -A	Brown	Embossed grain	Matte	Upholstery applications
 Sample – B	Blue	Smooth micro-grain	Semi-gloss	Automotive interiors
 Sample – C	White	Fine matte texture	Matte	Upholstery materials
 Sample - D	Maroon	Subtle grain	Smooth	Fashion accessories
 Sample - E	White	Pebble grain	Matte	Footwear applications

synthetic leather due to the hydrophobic nature of PU polymers [6].

**3.6. Comparison with Previous Studies**

The developed material exhibited mechanical and physical performance comparable to commercial PU artificial leather products. However, the present method additionally offers efficient texture transfer and possible reuse of release paper, making it attractive for industrial production. Slight variations in strength values compared with earlier reports may be due to differences in PU formulation, coating thickness, curing temperature, and backing fabric composition.

**3.7. Overall Scientific Significance**

The results demonstrate that release paper technology is not only useful for improving appearance but also for producing synthetic leather with balanced strength, flexibility,

adhesion, and moisture resistance. A summary of the mechanical performance data is presented in Table 4. Therefore, the present study supports the industrial viability of PU-based artificial leather as a sustainable alternative to conventional natural leather [16,17]. The measured mechanical properties of developed PU artificial leather are illustrated in Figure 1.

**3.8. Engineering Significance and Industrial Feasibility**

The successful preparation of polyurethane artificial leather using release paper technology demonstrates the engineering applicability of transfer-coating processes for value-added polymer products. Uniform coating thickness and effective texture transfer indicate that the selected drying and curing conditions enabled stable film formation and adequate solvent removal. Proper control of temperature and residence time is essential in coating operations

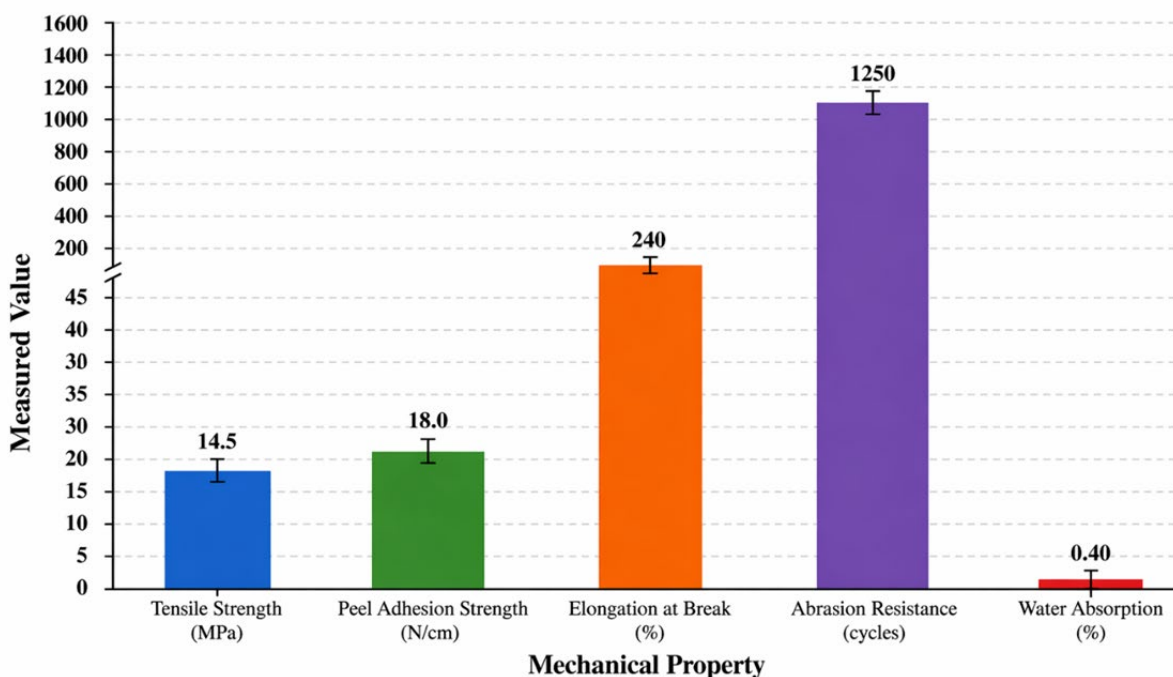


Figure 1. Bar chart showing mechanical properties of developed PU artificial leather.

Table 4. Mechanical performance of PU artificial leather [11].

Property	Observed Value	Interpretation
Tensile Strength	11 – 18 MPa	Adequate strength
Elongation at Break	180 – 300 %	Good flexibility
Peel Adhesion Strength	~18 N/cm	Strong bonding
Abrasion Resistance	1250 cycles	High durability
Water Absorption	~0.4%	Good water resistance

because insufficient drying may cause surface defects, whereas excessive heating may negatively affect polymer properties [5,7].

Lamination pressure also plays an important role in promoting interfacial adhesion between the polyurethane layer and textile backing substrate. The strong bonding observed in the present study suggests that suitable pressure and curing conditions improved interlayer contact and polymer consolidation. Similar effects of processing conditions on adhesion and coating quality have been reported for PU synthetic leather systems [3,8].

From an industrial perspective, release paper technology offers continuous production capability, reproducible surface finish, and higher manufacturing efficiency compared with conventional leather processing routes. In addition, the potential reuse of release paper and reduced dependence on chromium-based tanning chemicals may improve process sustainability. Therefore, the developed route shows strong potential for scale-up in footwear, upholstery, automotive interior, and fashion accessory manufacturing [6,7]. A comparison between developed material and reported commercial PU leather values is shown in Figure 2.

#### 4. Conclusions

The present study demonstrated that polyurethane-based artificial leather can be successfully produced using release paper technology with satisfactory surface quality and mechanical performance. The developed material showed adequate tensile strength, flexibility, adhesion, abrasion resistance, and water resistance for practical applications. Release paper technology offers advantages such as uniform finishing, controlled texture, and efficient production. The developed PU artificial leather has strong potential for use in footwear, upholstery, automotive interiors, bags, and fashion accessories. Future work may focus on bio-based polyurethane systems, recyclability, and improved breathability to further enhance sustainability. The present study was conducted at laboratory scale; pilot-scale validation is recommended for future work.

#### Acknowledgment

The authors sincerely acknowledge the Department of Chemical Engineering, IPS Academy, Indore, Madhya Pradesh, India, for providing laboratory facilities, technical support, and academic guidance during the course of this research work. The authors are also grateful to

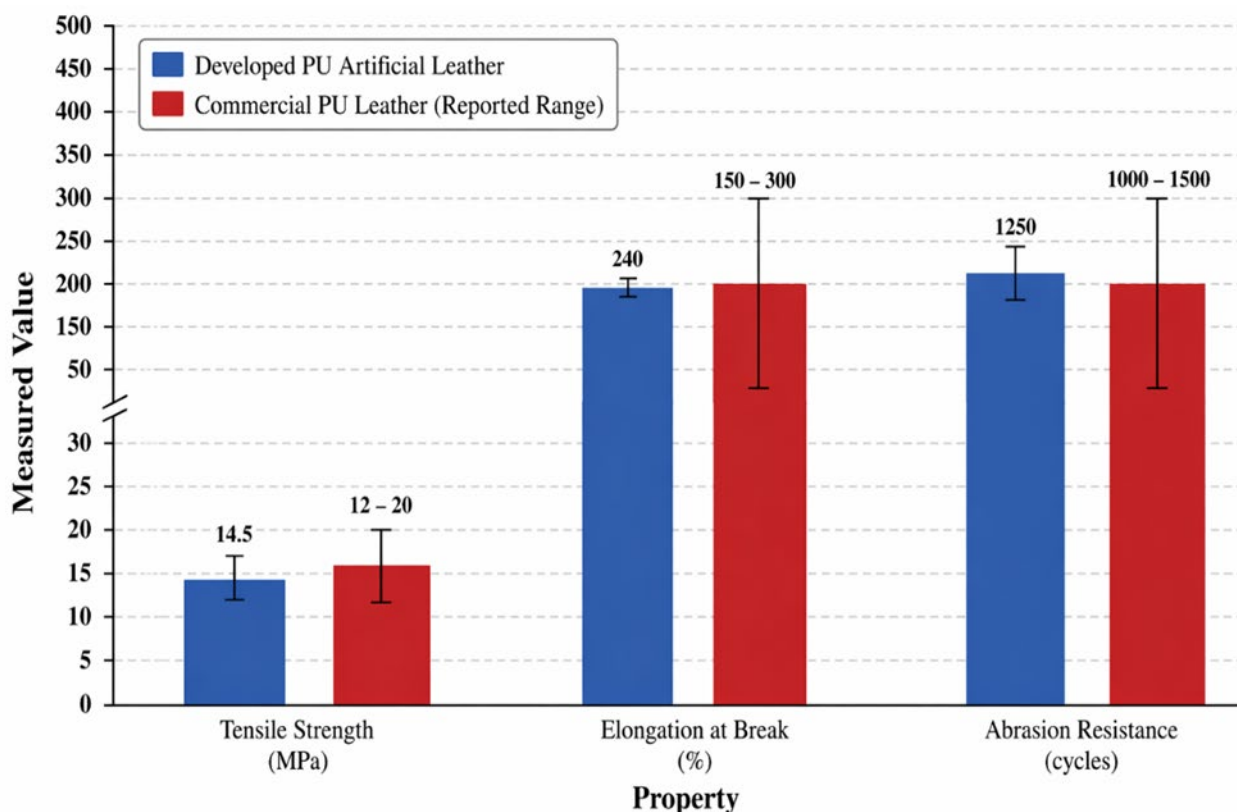


Figure 2. Comparison of developed PU artificial leather with reported commercial PU leather values.

the faculty members and staff of the department for their valuable assistance and encouragement throughout the study.

### Credit Author Statement

Author Contributions: Siddhi Shukla: Conceptualization, Investigation, Experimental work, Data curation, Formal analysis, Visualization, Writing – original draft preparation, Project administration. Rajesh Kumar Kaushal: Supervision, Methodology guidance, Validation, Review and editing. Vikas Vishwakarma: Technical support, Data review, Review and editing. All authors have read and agreed to the published version of the manuscript.

### References

- [1] Birlie, A.A. (2025). Transforming the leather industry: A comprehensive review on leather alternatives. *Journal of Renewable Materials*, 13(9), 1783-1802. DOI: 10.32604/jrm.2025.02025-0039.
- [2] Risteski, S., Zhezhova, S., Jordeva, S., Dimitrijeva-Kuzmanoska, V., Golomoeva Longurova, S. (2025). Analysis of plant-based leather as a sustainable alternative to traditional animal leather. *Koža obuća (Online)*, 74(3), 7-11. DOI: 10.34187/ko.74.3.3.
- [3] Wang, Y., Li, X., Chen, Y. (2021). Research on innovation and application of thermoplastic polyurethane elastomer bionic leather fabric from the perspective of sustainable design. *IOP Conference Series: Earth and Environmental Science*, 706(1), 012032. DOI: 10.1088/1755-1315/706/1/012032.
- [4] Rajput, E.B., Kurien, D. (2025). Strategic sourcing of fashion accessories: The China plus-one plan for a pureplay fashion retailer. *International Journal of Advanced Engineering, Management and Science*, 11(5), 50-63. DOI: 10.22161/ijaems.115.7.
- [5] Sur, S.H., Choi, P.J., Ko, J.W., Lee, J.Y., Lee, Y.H., Kim, H.D. (2018). Preparation and properties of DMF-based polyurethanes for wet-type polyurethane artificial leather. *International Journal of Polymer Science*, 2018, 1-9. DOI: 10.1155/2018/7370852.
- [6] Tian, S. (2020). Recent advances in functional polyurethane and its application in leather manufacture: A review. *Polymers*, 12(9), 1996. DOI: 10.3390/polym12091996.
- [7] Liu, J., Recupido, F., Lama, G.C., Oliviero, M., Verdolotti, L., Lavorgna, M. (2023). Recent advances concerning polyurethane in leather applications: An overview of conventional and greener solutions. *Collagen and Leather*, 5(1), 8. DOI: 10.1186/s42825-023-00116-8.
- [8] Shi, Z., Kwok, M.H., Ngai, T. (2025). Porous surface coating fabrication for polyurethane synthetic leather: A review. *Collagen and Leather*, 7(1), 37. DOI: 10.1186/s42825-025-00219-4.
- [9] Dau, S.H., An, K.L.N. (2026). Automatic inspection of surface defects in synthetic leather using optical techniques combined with image processing. *Journal of Physics: Conference Series*, 3180(1), 012072. DOI: 10.1088/1742-6596/3180/1/012072.
- [10] Chaouch, W., Hamdi, T., Jmali, M., Msahli, S. (2025). New non-woven product from PVC/PET artificial leather wastes: Physicomechanical properties and abrasion performance study. *Journal of Industrial Textiles*, 55, 15280837251381082. DOI: 10.1177/15280837251381082.
- [11] Bureau of Indian Standards. (2008). IS 15776:2008 Polyurethane (PU) Coated Leather. New Delhi, India.
- [12] Qin, Y., Liu, Y., Kuang, G., Zhou, Y., Xin, B. (2023). Study on modification and application of functional polyurethane in leather finishing. *Journal of Physics: Conference Series*, 2470(1), 012030. DOI: 10.1088/1742-6596/2470/1/012030.
- [13] Wang, W. (2022). Organosilicon leather coating technology based on carbon peak strategy. *Journal of Leather Science and Engineering*, 4(1), 27. DOI: 10.1186/s42825-022-00101-7.
- [14] Naderizadeh, S. (2025). The thermal and mechanical performance of leather waste-filled bio-based thermoplastic polyurethane composites. *Polymers*, 17(9), 1202. DOI: 10.3390/polym17091202.
- [15] Shi, Z., Sheng, Y., Wu, J., Cui, J., Lin, W., Ngai, T. (2024). Porous waterborne polyurethane films templated from Pickering foams for fabrication of synthetic leather. *Langmuir*, 40(9), 4751-4761. DOI: 10.1021/acs.langmuir.3c03514.
- [16] Polecki, K., Paciorek-Sadowska, J., Borowicz, M., Isbrandt, M., Zarzyka, I. (2026). Polyurethane recycling: Sustainable development perspectives and innovative approaches. *Materials*, 19(4), 805. DOI: 10.3390/ma19040805.
- [17] Choi, S.M., Lee, D.H., Zo, S.M., Sood, A., Han, S.S. (2025). Gel-based approaches to vegan leather: Opportunities and challenges in mimicking leather properties. *Gels*, 11(6), 395. DOI: 10.3390/gels11060395..