



# THERMOPLASTIC POLYURETHANE (TPU) FILM FOR ULTIMATE TRANSPARENT PROTECTION



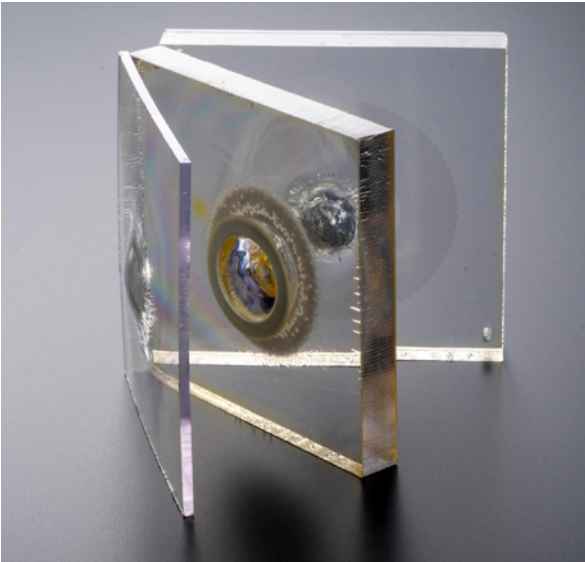
The High-Performance Choice for Safety, Durability, and Clarity

From building facades designed to resist blast and catastrophic weather to bullet-resistant windows for vehicles and interior spaces, security glazing provides transparent protection in an increasingly uncertain world.

Comprised of bonded layers of glass and plastic, security glazing protects by dissipating the energy of impact and blast while containing dangerous fragments. These functions depend on interlayer adhesive performance.

Proper interlayer selection and processing are critical to the overall safety and durability of the security glazing system. Additionally, security glazing must withstand many years of exposure to moisture, vibration, UV light and temperature extremes.

Covestro’s Dureflex® and Platilon® thermoplastic polyurethane (TPU) films are specifically formulated to meet these challenges<sup>(1)</sup>. Dureflex® TPU is the high-performance choice for safety, durability, and clarity.



Optically Clear TPU Films for Security Glazing

| Product <sup>(1)</sup>          | Chemistry                              | Application                                                                                                                                           |
|---------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dureflex® A4500                 | Aliphatic polyether urethane           | Lower modulus mitigates thermal stress when bonding dissimilar materials such as glass and PC                                                         |
| Dureflex® A4700                 | Aliphatic polyether urethane           | High durability general purpose interlayer for glass and plastic lamination                                                                           |
| Dureflex® X2260                 | Aliphatic polyether urethane           | High modulus, high strength bonding for ballistic laminates that must perform at elevated temperatures                                                |
| Dureflex® ES2592 <sup>(2)</sup> | Dual-layer aromatic/aliphatic urethane | All-purpose laminate edge sealing for enhanced environmental durability and aesthetics, compatible with all types of transparent interlayer adhesives |

(1) Covestro’s Dureflex® products are sold in Europe and other worldwide regions under the Platilon® brand. Information in this brochure applies equally to Dureflex® and Platilon® branded products.

(2) Outside (aromatic) layer of edge seal is black with embossed finish.

The TPU Advantage

Superior Environmental Durability

Compared with materials like PVB and EVA, the aliphatic polyether TPU formulations of the Dureflex® TPU family offer enhanced hydrolytic stability and improved resistance to bonding loss in hot/wet conditions. Additionally, the inherent UV stability and low glass transition temperatures of Dureflex® TPU, together with integrated adhesion promoters deliver a primerless bonding system that offers excellent performance.

Excellent Adhesion to Plastic

TPU offers excellent bonding to common transparent security plastics including polycarbonate and polymethyl methacrylate (acrylic). The absence of plasticizers and solvents in TPU allows safe use with plastics, whereas interlayer materials such as PVB contain incompatible elements that can cause stress cracking or crazing. TPU also provides outstanding adhesion to glass.

No Special Storage Requirements

PVB and EVA rolls must be dry-stored or refrigerated and sealed to prolong useful life. Notable yellowing and loss of bonding strength can result from exposure to moisture or light. TPU, due to its aliphatic structure, is naturally UV resistant and requires no special storage.

Reduced Energy Costs

TPU lamination temperatures are typically more than 30 °C lower than ionoplast, EVA and PVB. This translates into direct energy and time savings and allows co-lamination with temperature-sensitive plastics such as abrasion-coated polycarbonate. These plastics will normally be damaged by higher temperatures, resulting in distortion and cracking of the abrasion coating.

Design Versatility

TPU offers a wide range of mechanical properties to meet unique application requirements. For example, Dureflex® X2260 TPU film provides higher hardness and stiffness to enhance structurally demanding applications. Softer materials such as Dureflex® A4500 TPU film are well suited to manage high bond strain that may be found in flexible systems or in plastic-glass hybrid systems where thermal stress is prevalent.

Easy Processing

TPU processing can accommodate a wide range of cooling rates without risk of haze formation. This is especially valuable in the production of thick laminates that cannot be quickly cooled without development of residual stress that contributes to distortion and early delamination failure. TPU also bonds equally well to both the air and tin sides of glass, thus simplifying laminate construction.



Applications across multiple industries:

Dureflex® TPU formulations are designed to meet the specific demands of security glazing applications. Tailored properties include high adhesive strength for glass and plastic, toughness, and good melt flow. With the proper configuration, these films are capable of meeting the most stringent performance requirements, including EN 356, EN 1063, EN 13541, STANAG 4569, and VPAM PM2007, among others.



**Vehicle  
Armoring**



Military vehicles, police cruisers, and civilian VIP transport demand the highest level of protection without added weight or reduced visibility



Our Dureflex® TPU solutions enable multi-hit ballistic resistance while maintaining optical clarity essential for driver and passenger safety



**Aerospace and  
Transportation**



The wide temperature range, elasticity and excellent tear resistance of Dureflex® TPU make it an ideal interlayer choice for large-span windshields in trains, buses, and aircraft



Whenever the utmost in clarity and impact safety are required, Dureflex® TPU is the right choice



**Architectural  
Safety**



From residential high-rises to government facilities, Dureflex® TPU provides protection against severe weather, forced entry, and ballistic or blast threats



The excellent clarity and UV stability of Dureflex® TPU ensure lasting aesthetics while meeting increasingly stringent building codes for safety and security



**Retail and  
Public Safety**



Banks, stores, and schools face unique security challenges



Dureflex® TPU creates secure, invisible protection barriers that support surveillance and promote natural human interaction



TPU Films for Security Glazing

Dureflex® TPU Films for Security Glazing\*

| Film Grade               |              | A4500               | A4700               | X2260               | ES2592<br>Edge Seal           |
|--------------------------|--------------|---------------------|---------------------|---------------------|-------------------------------|
|                          | Film Type    | Polyether Aliphatic | Polyether Aliphatic | Polyether Aliphatic | Aromatic/Aliphatic dual layer |
|                          | Self-Priming | Yes                 | Yes                 | Yes                 | Yes                           |
| Hardness                 | Shore A      | 68                  | 78                  | 95                  |                               |
| Tensile Strength         | psi<br>MPa   | 3,500<br>24.1       | 5,500<br>37.9       | 9,000<br>62.1       | 9,000<br>62.1                 |
| Tear Resistance          | pli<br>kN/m  | 225<br>39.4         | 250<br>43.8         | 440<br>77.1         | 350<br>61.3                   |
| Elongation (Ult.)        | %            | 750                 | 500                 | 375                 | 550                           |
| TMA Onset Softening Temp | °F<br>°C     | 153<br>67           | 169<br>76           | 194<br>90           | 176<br>80                     |
| Lamination Temperature   | °F<br>°C     | 200–240<br>95–115   | 200–250<br>95–120   | 210–250<br>100–120  | 200–250<br>95–120             |
| Available Gauges         | µm           | 635, 1270           | 380, 635, 1270      | 380, 635            | 635                           |
| Available Roll Widths    | mm           | 1016, 1270, 1524    | 1016, 1270, 1524    | 1524                | 1092                          |

\* The product data listed is for general information only. The values are approximate and should not be considered part of the product specifications.



Key Properties

Dureflex® A4500

- Self-priming, polyether-based, aliphatic TPU film
- Engineered for low modulus and high elongation
- Ideal for laminating challenging PC-to-glass and asymmetric laminates
- Typically used at 1270 µm thickness (customizable from 635 to 1270 µm)
- Matte finish for efficient air evacuation during press or autoclave bonding

Dureflex® X2260

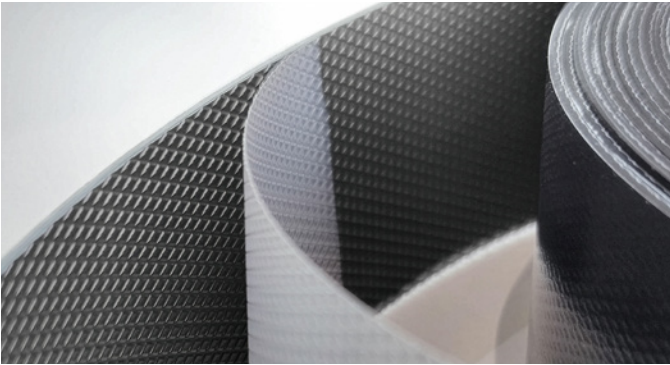
- Enhanced self-priming, polyether-based aliphatic TPU film
- High ballistic efficiency allows for thinner glass and lighter overall construction
- Used in military and high-security applications
- Withstands the heat of embedded heating wires used in military de-icing systems
- Wider application temperature range (withstands both colder and hotter temperatures)
- Resists delamination at extreme temperatures
- Compatible with A4700 and A4500 in the same laminate

Dureflex® A4700

- Self-priming, polyether-based, aliphatic TPU film
- Excellent impact and puncture resistance, optical properties, and adhesion
- Formulated for bonding PC-to-PC, PC-to-glass, and acrylic-to-glass security laminates
- High elasticity for bridging different materials and compensating for temperature-related expansions

Dureflex® ES2592

- Multilayer TPU film for edge protection of glass-clad laminates



- Compatible with all common interlayers (TPU, PVB, EVA, Ionoplast)
- Seals laminate to resist moisture, chemicals, and liquid penetration
- Minimizes edge chipping
- Provides visually appealing product



Scan to learn more about our TPU films  
for security glazing

The manner in which you use our products, technical assistance and information (whether verbal, written or by way of production evaluations), including any suggested formulations and recommendations, is beyond our control. Therefore, it is imperative that you test our products to determine suitability for your processing and intended uses. Your analysis must at least include testing to determine suitability from the technical, health, safety, and environmental and regulatory standpoints. Such testing has not necessarily been done by Covestro, and Covestro has not obtained any approvals or licenses for a particular use or application of the product, unless explicitly stated otherwise. Any samples provided by Covestro are for testing purposes only and not for commercial use.

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