

Design
Fabrication
ETFE Film Structures
Installation
Service



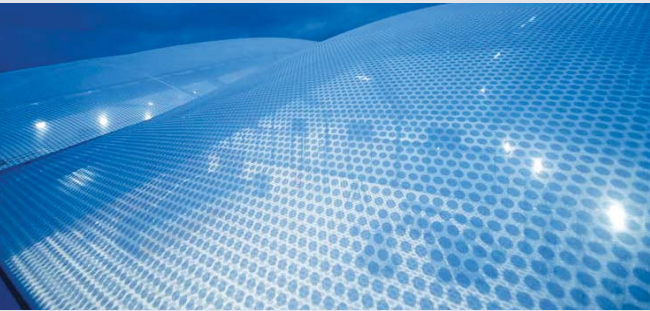
BIRD AIR

Tensile Architectural Structures

What is ETFE film?

It's the new generation material which goes beyond glass.

ETFE (*Ethylene Tetrafluoroethylene*) film is durable, highly transparent and very lightweight in comparison to glass structures. ETFE is being considered the material of choice for traditional skylight applications to long span structures and building facades. Few building materials can match ETFE for its impact or presence when you want a structure that stands out from the crowd.



History of ETFE

- ▶ Originally developed by DuPont over 40 years ago as an inert coating material for the aerospace industry.
- ▶ First application in the building industry took place in the early 1980s in Europe.
- ▶ Gained recognition with three major projects, the Eden Zoo Project in 1998, the Allianz Arena for the 2006 Soccer World Cup and the "Water Cube" at the 2008 Beijing Olympics.

Construction Technology

Single Layered Application

ETFE film can be applied in a single layer form and is reinforced with cables, lightweight steel or aluminum to maintain shape and stability.



Double or Triple Layered Application

ETFE film incorporates a pneumatic system to maintain air between 2 or 3 layers of film restrained in aluminum extrusions and supported by a lightweight structure creating inflated cushions. These cushions are filled with low-pressure air, providing thermal insulation and structural stability against wind or snow loads. If needed, small cables can be used for reinforcement. Under typical loading conditions, ETFE cushions can range from 5 to 15 feet wide and reach up to 200 feet in length.

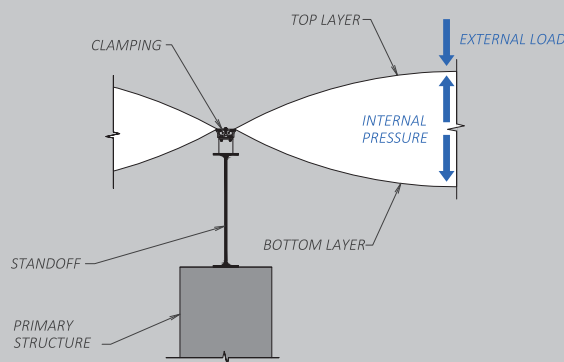




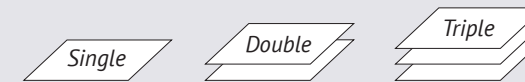
Air Inflation System/ Energy Consumption

A pneumatic ETFE cushion system is generally supplied by one or more inflation units. Each unit consists of two redundant blowers forming a backup system for guaranteed structural stability. The air when entering the machine will be dried to avoid condensation within the cushions. A series of pressure sensors continuously monitor the internal pressure of the ETFE cushions maintaining them between 5 psf and 6 psf. In case of high wind or snow loads, sensors can automatically and continuously adapt the pressure to compensate external loading.

Depending on air temperature and humidity, one unit can supply a roof of up to 15,000 square feet. These units are UL certified and run on an 110V power with consumption less than 1kW/h.



Thermal Performance



| ETFE Layers | U-Value (W/m ² K) | R-Value (FT ² hrF/BTU) |
|-------------|------------------------------|-----------------------------------|
| Single | 5.7 | 1.0 |
| Double | 2.9 | 2.0 |
| Triple | 1.9 | 3.0 |

Fire Performance

ETFE films have been rated under different national and international standards as self-extinguishing with no burning drops. The film melts away at around 500° F.

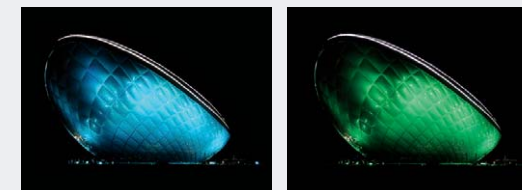
*Values represent typical performance, not specification limits.

Typical* Performance of ETFE Film

| 10 Mil (250 Micron) | Test Method |
|---------------------|--|
| VTM - 0 | UL 94VTM |
| Class A | ASTM E84 |
| Class A | ASTM E108 |
| B-s1, d0 | DIN EN 13501-1 |
| pass | CAN/ULC-S109-03 small & large flame tests |
| FSR = 5 | CAN/ULC-S102-07 |
| SDC = 100 | CAN/ULC-S102-07 |

Photovoltaic and LED Integration

Flexible photovoltaic (PV) cells and/or LED lighting can be integrated with either a single layered or cushioned system to meet performance and/or aesthetic requirements.



Benefits of ETFE

Light Transmission

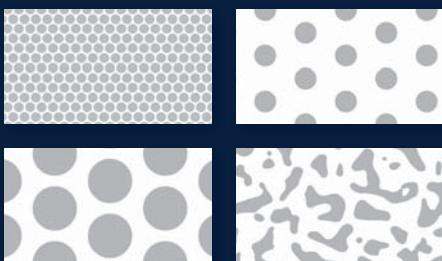
ETFE films can be highly transparent (from 90% to 95%) and allow for the passing of UVs which are responsible for the promotion of photosynthesis, thus facilitating plant growth. As a result of UV transparency, the film will not discolor or weaken structurally over time.

Cost Effective

Due to the lightweight nature of ETFE, substructure support systems and concrete foundations can be designed more efficiently. ETFE systems also provide ample natural daylighting, thus minimizing energy costs by lowering the demand for indoor lighting.

Solar Control/Shading

ETFE film systems can incorporate a number of frit patterns on one or multiple layers to alter their solar performance. The film is printed with various standard or custom patterns. Some typical standard patterns are:



Sustainable

From extruding of the film to transportation to site, compared to other similar cladding material, little energy will be consumed, thus reducing the overall carbon footprint. In addition, the nature of ETFE systems enhances the building physics through insulation and daylighting, contributing to the global low energy aspect of the building.

Longevity

Under exposure to environmental pollution, UV light, harsh chemicals, or extreme temperature variations, ETFE does not degrade.

| Property | Unit | Original Value | Value After Weathering | | | | | |
|--------------------------|-------------------|----------------|------------------------|--------|--------|--------|--------|---------|
| | | | 1 Year | 2 Year | 3 Year | 5 Year | 7 Year | 10 Year |
| Tensile strength (md) | N/mm ² | 46.7 | 45.6 | 46.2 | 44.9 | 46 | 48.4 | 52.4 |
| Tensile strength (cd) | N/mm ² | 42.3 | 43.8 | 45.5 | 42.6 | 44.8 | 42.4 | 44.6 |
| Yield strength (md) | N/mm ² | 22.6 | 22.5 | 25.0 | 22.3 | 23.2 | 22.8 | 22.5 |
| Yield strength (cd) | N/mm ² | 18.8 | 21.4 | 22.0 | – | 22.3 | 21.0 | 21.5 |
| Elongation at break (md) | % | 330 | 340 | 310 | 345 | 315 | 325 | 340 |
| Elongation at break (cd) | % | 390 | 405 | 390 | 390 | 410 | 390 | 405 |
| Tear strength (md) | N/mm ² | 420 | 430 | 415 | 445 | 440 | 523 | – |
| Tear strength (cd) | N/mm ² | 435 | 425 | 420 | 480 | 430 | 531 | – |
| Light Transmission | % | 95 | 96 | 94 | 95 | 96 | 96 | 96 |

md = machine direction • cd = cross direction

Test results / weathering test in Arizona, USA, on Hostaflon ET films (source Hoechst, Dyneon, 3M)

Recyclable

Easily recyclable, waste from the manufacturing process or even old ETFE elements can be remolded into new ETFE products such as tubing components and wires.

Colors

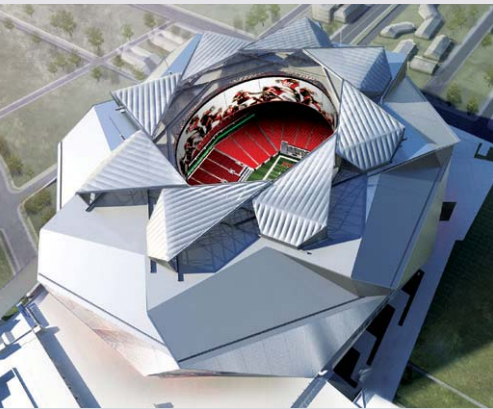
Colors can be introduced in a variety of ways. It can be applied during the film extrusion process providing a consistent tint in various tones from red to violet or by adding colored lighting with changeable color options.





Maintenance/Cleaning

Due to the non-adhesive surface properties of ETFE film, deposits of dirt, dust, and debris do not stick and are washed away by the rain resulting in a “self-cleaning” effect. However, as with every mechanical equipment system, it is necessary to perform a yearly inspection. The inspection includes all necessary checks on the air inflation units and filter replacements. The ETFE film and its attachments will also be inspected in an effort to maintain a smooth and efficient operating system.



Safety

Due to the high resistance and elasticity of ETFE film, it is an ideal building component when sudden extreme loads such as earthquakes or blasts may occur. Unlike glass that will shatter and cause major concern under similar shock load situations, ETFE will either deflect under load or in case of breakage, is unlikely to cause any major damages. ETFE has been classified as a non-fragile roof in the UK. ETFE, however, is not suitable as a vertical railing and cannot prevent from intrusion.

Who is Birdair?

Birdair is the leading specialty contractor for custom tensile membrane structures throughout the world.

With more than 55 years of experience, Birdair has worked with owners, architects, engineers and contractors to design and build custom tensile structures used to create innovative roofing systems, canopies and skylights. As a turn-key specialty contractor, Birdair provides pre-construction assistance; including design assistance, budgeting, construction methodologies and project schedule development. Our in-house capabilities consist of design, engineering, fabrication, installation and maintenance.

Working closely with architects and their clients, Birdair assists in delivering award-winning solutions by taking an idea and building an icon. Our work ranges from secure transportation terminals to sports venues and convention centers; from festive entertainment, performing arts facilities and museums to offices, hotels, resorts and visitor centers; from eye-catching retail complexes to walkways and porte-cocheres. To date, the company has completed more than 1,300 major installations in more than 30 countries, requiring over 30 million square feet of architectural fabric membrane.

Birdair is committed to the ongoing development of tensile architecture, working diligently to further promote the most modern technologies available and to continually innovate signature, high-quality designs.



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