

The mineral fluorite is the base of the composite polymer ETFE



**ETFE'S MATERIAL QUALITIES**

- Lightweight: about 1/100 of the weight of glass
- Low cost: approximately 50 per cent of glass. Not cost effective on projects under 200m<sup>2</sup>
- Long spans: up to 250m long
- Insulation: U-values down to 0.2Wm<sup>2</sup>K
- Solar shading range of 1-90 per cent or opaque
- Embodied energy less than 1 per cent of glass
- 100 per cent recyclable
- Shrinks when exposed to fire, thus ventilating smoke
- Naturally non-stick, so exterior surface self-cleans

ETFE was first patented by DuPont in the 1940s, but went commercial in the 1970s when US manufacturer DuPont and Hoechst in Germany launched ETFE wire and cable insulation. Vector Foiltec, a sailmaking firm set up in 1982, pioneered the architectural use of ETFE. Vector Foiltec, located in Bremen, Germany, is now the leading fabricator of ETFE cushions and claims an 86 per cent market share – although new companies such as Hightex and Covertex, both based in Europe, are providing competition.

The material comprises cushions of two or more layers

secondary structure. Extrusions are usually aluminium due to its flexibility and affordability, but they can also be made of carbon, steel or stressed cables. It is advisable to specify the cushion shape and size before designing the frame.

Multi-layered cushions allow architects to customise the envelope to a greater degree than more traditional materials. The U-value, for instance, depends on the number of layers of foil in each cushion, ranging from 2.94Wm<sup>2</sup>K for two layers to 1.18Wm<sup>2</sup>K for five-layer assembly. 'With anything above five layers it is more cost effective

each layer of material,' explains Morris.

'All the fabricators in Europe source ETFE from the same suppliers so the base foil is identical,' says David Walker, managing director of Hightex UK. The difference between suppliers is the additional technology that they use, which can add to the cushions. Vector Foiltec, for example, has synthesised integrated LED lighting grids into inflated cushions, allowing architects the chance to fuse transparent enclosures with information technology to create vast graphic envelopes. Hightex, which supplies a range of membrane materials, is creating hybrid cushions that combine ETFE with more traditional fabrics like PTFE-coated glass.

'It's wrong to think that ETFE is just a cling-film wrapping,' says Geoff Crowther, architectural director at Ron Arad Associates, which is using the material on its Mediacity project (see page 92). To ensure the best performance of ETFE, given its particular qualities, all three manufacturers recommend that architects employ a specialist contractor in the early stages of design. In terms of safety, for instance, designers need to bear in mind that ETFE can be cut with a knife. Thus residential application may be questionable, and the manufacturers recommend only specifying the material on parts of the building that are inaccessible.

'Architects can approach us at any stage,' says Walker. 'But there are benefits in coming to us early as we can give them ideas, advise on the detailing and point out any pitfalls.' >>

# BLOWING UP

Lightweight and sustainable, ETFE is the material of the moment – but many still don't know how or why to use it, writes *Cathy Strongman*

Since 2001, when the eight ETFE (ethylene tetrafluoroethylene) domes of Grimshaw Architects' Eden Project turned a disused clay pit in Cornwall into a visitors' centre bursting with a lush array of plants, the material has seen a tremendous increase in demand. Affirming this trend, last month Birkhäuser published *ETFE Technology and Design* by Annette LeCuyer, an in-depth analysis of the material and its applications. Most recently, ETFE has been used on the 'Water Cube' – the National Aquatics Centre in Beijing by Arup, PTW Architects and Chinese practice CCDI (AJ 17.04.08).

with air trapped in-between. These cushions are prefabricated and transported deflated to site, where they are fitted into aluminium extrusions fixed to the primary frame and linked through valves to the inflation system – which typically consists of a unit attached to a ring main or radial system with smaller spurs adhered to each cushion. Next, they are inflated to stabilise the envelope.

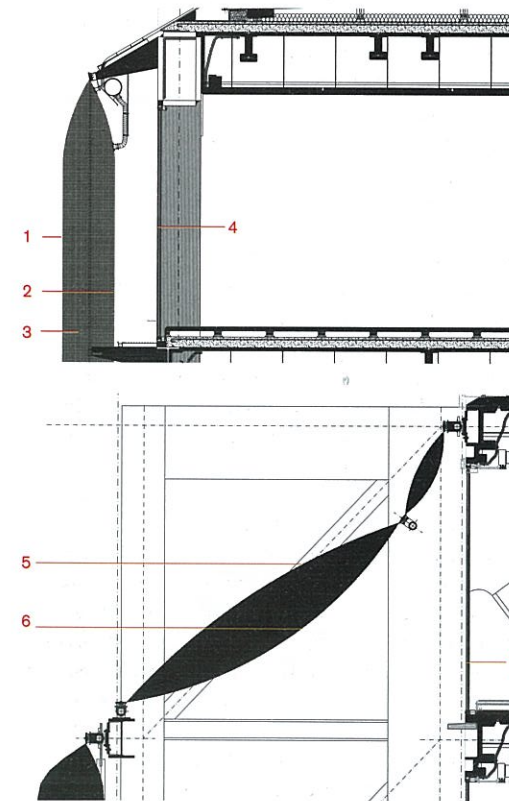
The cushions are shaped into long stripes or tessellating shapes such as hexagons or triangles. Once the shape and size have been decided, the structural grid is developed. ETFE systems typically rule out the need for a

to incorporate a laminated layer of nanogel, which is like aerated sand, into the cushion,' says Ben Morris, managing director of Vector Foiltec. 'This is a technology that we've patented and means we can get the U-value down to 0.2Wm<sup>2</sup>K.'

ETFE can also be pigmented or printed with a range of coloured opaque or translucent fluoropolymer inks to create a variety of decorative effects. The most common pigment is silver, which is typically used to reflect solar light and heat. 'The degree of solar shading is infinitely variable because dot patterns can range from 10 per cent transparency to opaque on



WALL SECTION DETAIL

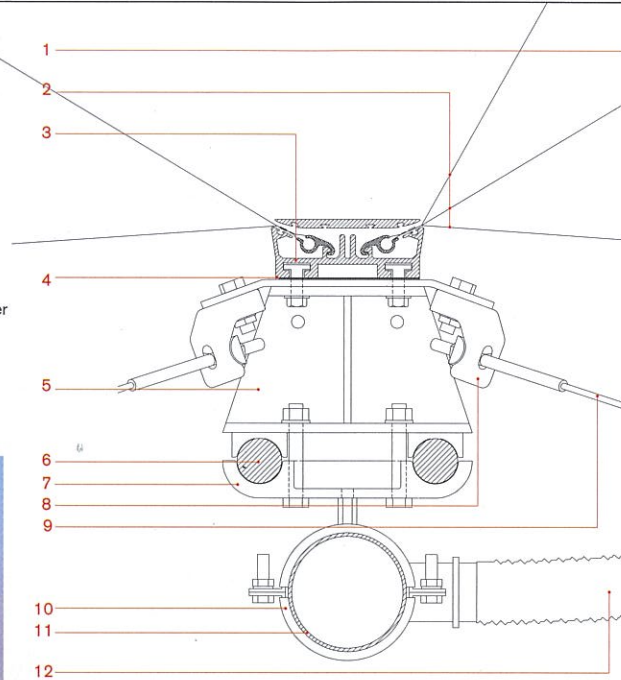
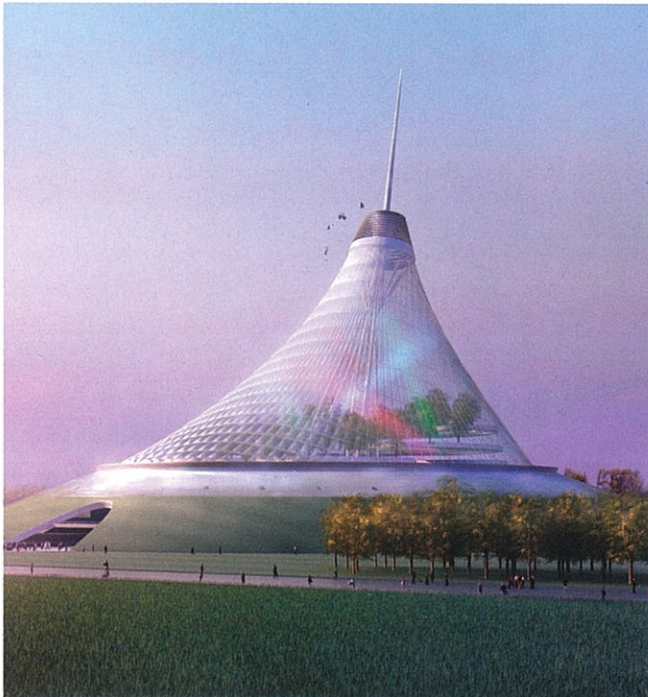


**MEDIA-TIC BUILDING, BARCELONA**  
 Architect Enric Ruiz Geli/Cloud 9 Gross area 23,104m<sup>2</sup> Completion date January 2009

The MEDIA-TIC building will be an IT and media communications hub clad in 2,500m<sup>2</sup> of ETFE. The south-east facade has a variable ETFE skin to control solar gain, comprising a three-layer cushion. By varying the air pressure within the cushion's two air cavities the middle and exterior layer can be joined together to create shade (the patterns connect to create an opaque surface) or moved apart to allow sunlight to filter through. Solar gain on the south-west facade is controlled by liquid nitrogen that is periodically pumped into the cushions. 'It's a bit like a smoke machine at a disco,' says Morris. The system activates itself automatically with a temperature sensor network.

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|---|--|--|
| 1. 200µm ETFE layer vertical printing 15 per cent | 4. Double glazing module U-value 2.8W/m <sup>2</sup> K | 6. 200µm ETFE layer negative dots printing opacity 63 per cent |
| 2. 200µm ETFE layer vertical printing 30 per cent | 5. 200µm ETFE layer green dots printing 19 per cent    | 7. Double glazing module U-value 2.8W/m <sup>2</sup> K         |
| 3. Fog atmosphere 40 per cent                     |  |  |

- 1. Cushion valve
- 2. Texlon foil cushion, three layers
- 3. Texlon foil extrusion
- 4. EPDM thermal separation
- 5. Spacer
- 6. Cable
- 7. Spacer clamp
- 8. Snow wire hanger
- 9. Snow wire
- 10. Flexible pipe
- 11. Pipe clamp
- 12. Pipe



DETAIL SECTION: CUSHION EXTRUSION AND AIR SUPPLY CONNECTING ETFE CLADDING TO BASE STRUCTURE

**KHAN SHATRY ENTERTAINMENT CENTRE, ASTANA, KAZAKHSTAN**

Architect Foster + Partners **Gross area** 100,000m<sup>2</sup>  
**Completion date** 2009

The Khan Shatry building, which rises 200m from an elliptical base to form the highest peak on the Astana's skyline, will provide a sheltered climatic envelope for an internal park, shopping and entertainment venue. The tent-like cable net structure is clad in ETFE to allow natural light to enter the complex while protecting it from temperatures ranging from -35°C to 35°C.

**MEDIACITE, LIEGE, BELGIUM**

Architect Ron Arad Associates **Contract value** 16.5 million euros (£13 million) **Gross area** 6,500m<sup>2</sup> **Completion date** August 2009

This 350m-long shopping mall weaves through the 40,000m<sup>2</sup> Mediacite. A network of steel roof ribs that vary both in structural depth and height are clad in ETFE. The architect specified four layers of ETFE foil to meet the clients' demand for high U-values, and a 70 per cent dot matrix is printed on the material to restrict solar gain. ■

