



**TensoSky<sup>®</sup>**  
ETFE SYSTEM

  
UNDER ONE ROOF

**Taiyo Europe**  
**MakMax**

Setting the **Global Standard** for Tensile Architecture

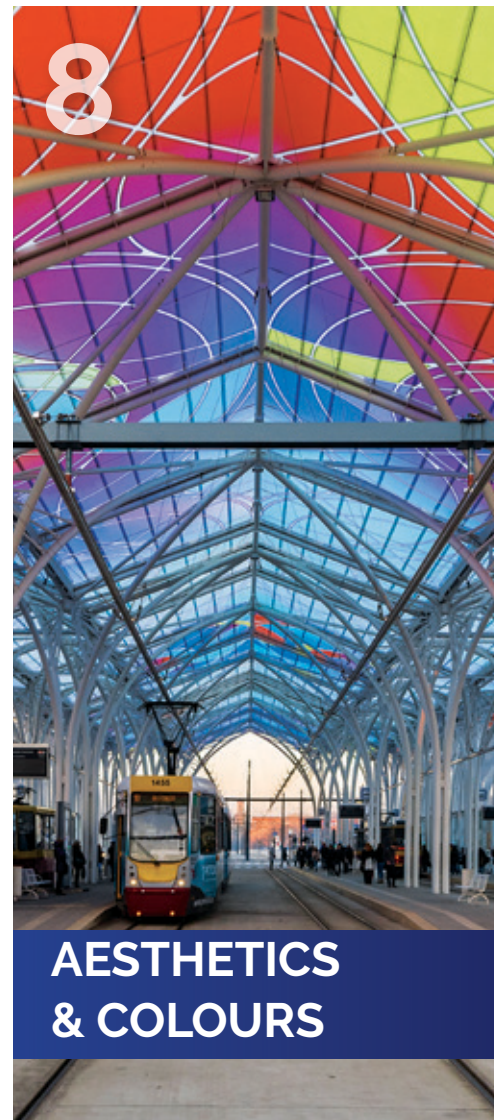




## TRANSPARENCY & PROTECTION



## FLEXIBILITY



## AESTHETICS & COLOURS



## BROAD PERSPECTIVES



## SPATIAL VISIONS

## TensoSky® ETFE SYSTEM

Taiyo's TensoSky ETFE system presents architects, engineers, contractors and clients with a state of the art roof and facade technology using the transparent, lightweight, flexible and resistant ETFE (Etilenetetrafluorethilene) membrane foil.

TensoSky has a multitude of configurations being applied as a monolayer or in multi-chamber pneumatic cushion compositions, also offering additional variable shading system and a multitude of accessories, variable shading system and a variety of accessories

Resistent to most extreme conditions, TensoSky systems have been used for many different applications all over the world – in extremely cold regions (-26°C) and in very hot desert zones (+50°C).

On the following pages explore with us the multiple applications of this exclusive transparent membrane system and its technical advantages.

We at Taiyo are passionate for innovative membrane solutions - and we are ready to support you on your next outstanding project.

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# TRANSPARENCY & PROTECTION

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## MACQUARIE UNIVERSITY ARTS PRECINCT

The Macquarie University Arts Precinct TensoSky roof is an incredibly light structure that thanks to its transparency, brings light, comfort and protection to those enjoying its roof garden and open-air atrium.

Year of Construction: 2020

Architect: BNHM Architects & Architectus

Engineering: Taiyo-MakMax Australia, Australia

Size/Material: 2,000 m<sup>2</sup> TensoSky 2-layer

Location: Sydney, Australia

## A UNIQUE EXPERIENCE



## RUHR PARK SHOPPING CENTER

The open air shopping experience on the Ruhr Park is exceptionally improved by the protective TensoSky canopy that embraces the stores. The full design-built TensoSky single layer, steel and cables was completed by Taiyo.

Year of Construction: 2012

Architect: Hütténes GmbH, Germany

Engineering: Maas und Partner, Germany; Konstruct AG, Germany

Size/Material: 690 m<sup>2</sup> TensoSky monolayer steel, cables and shading

Location: Bochum, Germany



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## MON GRAND PLAISIR SHOPPING MALL

The continuous transparent TensoSky multilayer system covering the complete shopping alley, coupled with a lightweight steel structure gives shopping enthusiasts, and daily workers a vibrant feeling of openness and warmth from daylight and casualty of nighttime.

Year of Construction: 2020

Architect: GR Design, France

Engineering: MAP3, France; Taiyo Europe GmbH, Germany

Size/Material: 4,000 m<sup>2</sup> TensoSky 2-layer

Location: Plaisir, France



## NEW JAHRA MEDICAL CITY

On the New Jahra Medical City Kuwait, natural daylight is a key feature, as it helps patients to feel more energized, with improved healing potential. TensoSky lightweightness and transparency is the perfect solution for environments where protection and the sense of openness merge.

Year of Construction: 2019

Architect: Pace, Kuwait

Engineering: Pace, Kuwait

Size/Material: 4,500 m<sup>2</sup> TensoSky 3-layer and steel structure

Location: Kuwait City, Kuwait



# FLEXIBILITY

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## LAKHTA CENTER

The Lakhta Center in Saint Petersburg (Russia) is the tallest twisted building in Europe. Following its concept, the Multifunctional Building (MFZ) located on its base consists of two multilevel parallel buildings, fluidly united by a continuous TensoSky Skylight. The flexibility of TensoSky along with its transparency and resistency ensures the harmony of geometry and sunlight, while resisting to the demands snow loads and low temperatures of the region.

Year of Construction: 2019

Architect: RMJM Architects, UK;  
Gorproject, Russia

Engineering: Maffei Engineering SpA, Italy;  
Taiyo Europe GmbH, Germany

Size/Material: 4,000 m<sup>2</sup> TensoSky 4-layer  
main steel structure

Location: St. Petersburg, Russia

# VARIETY OF SHAPES



## US EMBASSY

The secondary TensoSky monolayer facade of the US Embassy in London is composed of 399 pre-tensioned panels, installed on an articulated stainless steel and aluminum lightweight structure, creating a dynamic appearance while limiting excessive solar gain and distributing natural daylight on the building.

Year of Construction: 2017

Architect: Kieran Timberlake, USA

Engineering: Birdair, USA; ARUP, USA;  
Taiyo Europe GmbH, Germany

Size/Material: 8,125 m<sup>2</sup> TensoSky monolayer,  
cable and aluminium skeleton

Location: London, UK



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## CENTER PARCS LA VIENNE

The Vacation Centers of the Center Parcs chain are committed to provide guests with year long outside vacation experience. For such, its water and relaxation complex in La Vienne is covered with TensoSky multilayer systems. The solution transforms the roof into a myriad of shapes, while also being permeable to both natural light and UV rays all year long.

Year of Construction: 2015

Architect: ART'UR, France

Engineering: LEICHT GmbH, Germany

Size/Material: 6,200 m<sup>2</sup> TensoSky multilayer

Location: Vienne, France



## SPLIT AIRPORT

In the 1990's Taiyo built the PTFE-glass membrane front canopy of the main terminal. The satisfied client then asked Taiyo to also execute all TensoSky 4-layer skylights during the terminal's renovation, as well as the extension of the original canopy and the Bus Terminal, both consisting of PTFE-glass material.

Year of Construction: 2020

Architect: VV -PROJEKT d.o.o, Croatia

Engineering: RADNIC d.o.o, Croatia  
Taiyo Europe GmbH, Germany

Size/Material: 1,400 m<sup>2</sup> TensoSky 4-layer

Location: Split, Croatia



# AESTHETICS & COLOURS

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## THE AVENUES - BAHRAIN

The Avenues-Bahrain is a shopping mall along the Manama sea front. Keeping the open-air shopping experience on a protected, climatized and colourfully dynamic environment is its key feature. Therefore, Taiyo designed, fabricated and installed 13,000 m<sup>2</sup> of TensoSky 4-layer system. The structure comprises 130 cushions converging onto two fantastic ETFE flower-shaped domes.

Year of Construction: 2017

Architect: MSCEB, Bahrain

Engineering: Maffei Engineering SpA, Italy

Size/Material: 13,000 m<sup>2</sup> TensoSky 4-layer

Location: Manama, Bahrain

## SOPHISTICATION & DESIGN

## ŁÓDŹ TRAMSTATION

The lightweight steel structure of this important Tram Station elevates the colourful translucent TensoSky roof, creating this landmark building. This is the first large scale colour printed TensoSky. The structure consists of a mix of 3,000 m<sup>2</sup> uniquely printed roof and 600 m<sup>2</sup> of transparent facade, supported by stainless steel cables.

Year of Construction: 2014

Architect: FOROUM, Poland

Engineering: Buro Happold, Poland;  
konstruct AG, Germany

Size/Material: 3,600 m<sup>2</sup> TensoSky  
monolayer digitally printed

Location: Łódź, Poland

## COCA-COLA BEATBOX PAVILION

A pavilion designed for the 2012 London Summer Olympic that could be played like a musical instrument. The "work of art", consisting of 230 mutually stabilizing TensoSky elements, combines architectural design with the latest sound technology and invites visitors on a tour of discovery.

Year of Construction: 2012

Architect: P. Ohrstedt & Asif Khan, UK

Engineering: AKT II, UK, Leicht, Germany

Size/Material: 1,560 m<sup>2</sup> TensoSky 2-layer  
with incorporated sound system

Location: London, UK

## RENNES TRAIN STATION

The old station was transformed in order to simulate the typical regional landscape, which was possible due to the 3,500 m<sup>2</sup> TensoSky multilayer system. On the southern end of the building the roof is equipped with a movable layer system that gives the possibility of managing the solar gain value.

Year of Construction: 2019

Architect: AREP, France

Engineering: MAP3, France  
LEICHT France SAS, France

Size/Material: 5,200 m<sup>2</sup> TensoSky multilayer

Location: Rennes, France

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# BROAD PERSPECTIVES

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## AWM CARPORT MUNICH

Aesthetics and sustainability: the transparent TensoSky 3-layer roof of Munich's municipal waste management building with its integrated photovoltaic cells fulfils all requirements of a functionally and ecologically advanced structure.

Year of Construction: 2011

Architect: Ackermann und Partner  
Architekten BDA, Germany

Engineering: Ackermann Ing., Germany  
Konstrukt AG, Germany

Size/Material: 8,000 m<sup>2</sup> TensoSky 3-layer with  
incorporated photovoltaic system

Location: Munich, Germany

## TECHNOLOGY & INNOVATION



## ORIENTARIUM ZOO

The roof of the Botanical and Zoological Orientarium merges a frame of timber beams supporting the TensoSky multilayer structure. Because of the demanding thermal requirements, the 5-layer system combined with insulated connections make this roof one of few such realisations in the world.

Year of Construction: 2019

Architect: Szlachcic Architekci

Engineering: Taiyo Europe GmbH

Size/Material: 4,200 m<sup>2</sup> TensoSky 5-layer

Location: Lodz, Poland



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## SWATCH HEADQUARTERS

The roof of Swatch Headquarters consists of timber frames in 3D grids clad with a multitude of prefabricated composite elements. Almost 1,000 TensoSky individual composite elements which form parts of the grid structure were engineered, fabricated, and delivered for this project.

Year of Construction: 2018

Architect: Shigeru Ban Architects, Japan

Engineering: LEICHT GmbH, Germany

Size/Material: 3,700 m<sup>2</sup> TensoSky ETFE  
multi-layer composed system

Location: Biel, Switzerland



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## KHALIFA STADIUM

The New Khalifa International Stadium is the first football stadium worldwide to use Tensotherm, and the first one in the Arabian Gulf to use TensoSky monolayer cladding. With this unique membrane roof, the stadium is rated four stars by the Global Sustainability Assessment System (GSAS).

Year of Construction: 2017

Architect: DAR Al-Handasah, Qatar

Engineering: Maffei Engineering SpA, Italy

Size/Material: 55,700 m<sup>2</sup> of combined  
TensoSky monolayer,  
PTFE -glass fabric and  
Tensotherm system

Location: Doha, UAE

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# SPATIAL VISIONS

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## PLACE CHARLES ROGIER STATION

This iconic canopy in the heart of Brussels has an expressive 25 m cantilever structure. This was possible due to the seamless integration of the TensoSky monolayer roof and PVC membrane ceiling, which provides both a transparent waterproof cover, plus a chess board pattern of shading on the ground.

Year of Construction: 2018

Architect: XDGA, Xaveer De Geyter Architects, Belgium

Engineering: Taiyo Europe GmbH, Germany; Konstruct AG, Germany

Size/Material: 3,000 m<sup>2</sup> TensoSky monolayer; 1,200 m<sup>2</sup> PVC-polyester fabric

Location: Brussels, Belgium

## INTEGRATION & FORM

## THE ARC - RIVER CULTURE PAVILION

This architectonic masterpiece is constructed on the site where four rivers come together. The facade consists of a steel gridshell covered by specially-patterned TensoSky multilayer, which plays along with the different lighting of the building.

Year of Construction: 2012

Architect: Asymptote Architecture, Hani Rashid, USA

Engineering: Withworks, South Korea; Konstruct AG, Germany

Size/Material: 2,000 m<sup>2</sup> TensoSky 4-layer

Location: Daegu, South Korea

## LES VERGERS DE LA PLAINE

The open air commercial centre Le Vergers de la Plaine located in Chambourcy is dynamically integrated by 15 unique white and transparent TensoSky canopies. The stainless steel cable net ensures the stability of the anticlastic shapes, keeping its lightness and beauty.

Year of Construction: 2012

Architect: SCAU, Paris, France

Engineering: LEICHT GmbH, Germany

Size/Material: 4,500 m<sup>2</sup>; TensoSky monolayer

Location: Chambourcy, France

## CIIRC - TECHNICAL UNIVERSITY

The new Czech Institute of Informatics, Robotics and Cybernetics features an unique double skin ETFE facade envelope, improving acoustic performance while acts as a solar collector, improving the building's overall energy efficiency.

Year of Construction: 2016

Architect: Petr Franta Architects, Prague, Czech Republic

Engineering: LEICHT GmbH, Germany

Size/Material: 2,400 m<sup>2</sup>; TensoSky multilayer

Location: Prague, Czech Republic

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## PERFORMANCE

### DURABLE & CLEAN

UV resistant, ETFE films are high-end fluoropolymers with a durability of more than 25 years. Due to low coefficient of friction of its surface, dust or dirt will not stick onto the film.

### FIRE RETARDANT & ROBUST

ETFE films are flame retardant (B-S1, d0 according to EN 13501-1) and considered self-extinguishing. Therefore, it eliminates burning droplets or large smoke development.



### ENERGY TRANSMITTANCE

The G-value of an ETFE roof is the solar energy transmittance through the ETFE foil, which can be reduced with a printed frit pattern. Also depending on the parameters given for the thermal performance it can vary between approximately 0.1 and 0.9.



### TRANSPARENT & LIGHTWEIGHT

The ETFE-films used are permeable to both natural lighting and to parts of the UV-spectrum needed for general well-being and growth of plants and grass.

The range of thickness of the ETFE-films used vary between 0.05 and 0.50 mm. single and multilayer structures stabilized mechanically or pneumatically by inflated air have a surface weight between 0.5 and 5 kg per square meter. This allows for flexibility and a light weight supporting structure, especially when comparing to traditional transparent cladding systems such as glass.

### AIR SUPPLY

For air-inflated multi-layer structures, the TensoSky system includes air blower units that deliver the filtered, dried and compressed air into the system. Each unit consists of two redundant blowers forming a backup system for guaranteed structural stability. A series of pressure sensors will continuously monitor the internal pressure of the cushions.



### STRUCTURAL BEHAVIOR

The system carries and transfers all loads and load cases that are considered according to the Eurocode to the substructure or the primary structure.

### MODULAR

TensoSky can be applied as modular system or customized according to the project specific needs and the requests of the client and the architect.

### FLEXIBLE

TensoSky is aesthetically flexible. It enables an incredible diversity in terms of design, shape and appearance, from planar to single-curved or even double curved sophisticated free-form shapes of facades, roofs and building envelopes.



### CONTROLLABLE

The adjustment of the air-pressures in the different air chambers of pneumatically inflated multi-layer structures enables to move single printed layers to achieve a flexible and controlled shading just by changing of the air pressures.

### SOUND PERFORMANCE

Due to its low material mass, ETFE-foil structures have good sound performance with its sound absorption properties and low reverberation.

### PRINTABLE & COLOURABLE

ETFE can be produced in a wide range - from high transparency to colour-pigmented and opaque films, with matted to glossy finishings. It can also be printed with standard or unique design patterns, using reflective or digital colours.



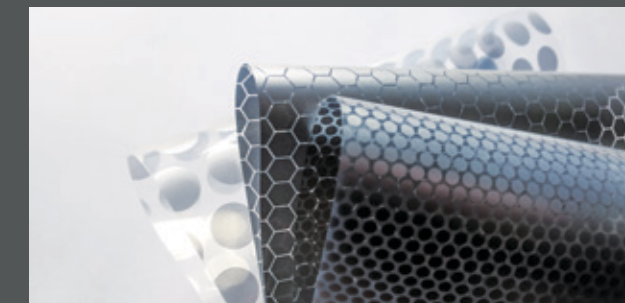
### SUSTAINABLE

The ETFE-film used is a thermoplastic material and, therefore, 100% recyclable. The environmental product declaration (EPD) and the fact sheets are showing exceptional performance of our TensoSky system due to its sustainability criteria.



### PATTERNS

Printing, also known as fritting, is a method to help reduce solar heat gain while retaining light transparency. In many cases, printing is also used to create projection screens for play of lights. Wherever diversity is an elementary part of architecture, printing in a large scale with different shapes and colours is getting more and more important.



### THERMAL PERFORMANCE

Depending on the number of layers, the printing/colouring of the films, the boundary conditions and the direction of the heat flow (upwards, downwards or horizontal), the TensoSky system achieves very good thermal performances. The thermal transmittance (Ug-value in W/(m²K) can be given approximately as follows:

- 1 layer: 5.7 – 6.3
- 2 layers: 2.7 – 3.3
- 3-layers: 1.7 – 2.3
- 4-layers: 1.3 – 1.7
- 5 layers: 1.0 – 1.4



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