



# Fraunhofer

## POLO

FRAUNHOFER POLYMER SURFACES ALLIANCE POLO



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## TRANSPARENT HIGH BARRIER FILM FOR ORGANIC ELECTRONICS ROLL-TO-ROLL PILOT PRODUCTION

### Fraunhofer Polymer Surfaces Alliance POLO

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Flexible organic electronic devices have to be protected from water vapor and oxygen in order to guarantee an adequately long lifetime.

The Fraunhofer Polymer Surfaces Alliance POLO has developed a technology for modifying polymer films with a layer system that is almost impermeable to water vapor and oxygen, without significantly impairing the flexibility and optical transparency of the film.

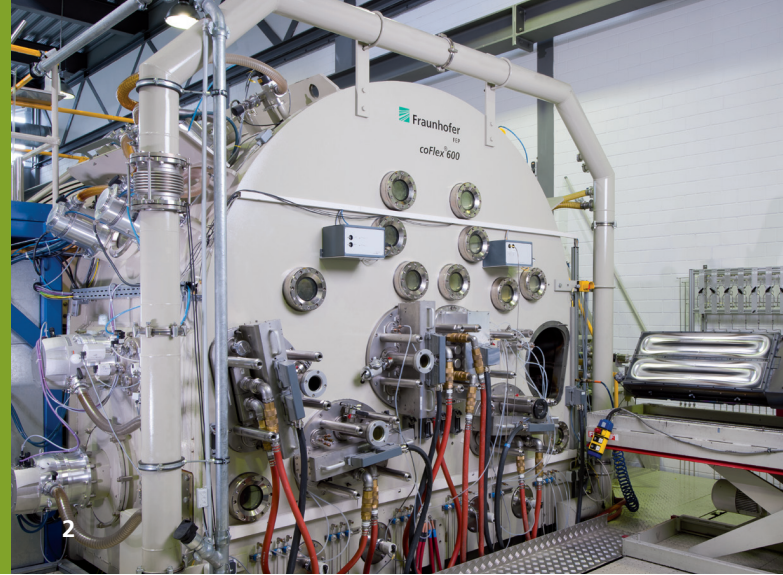
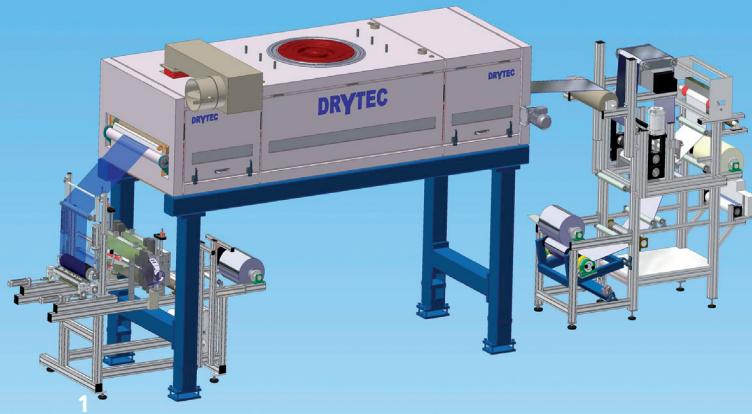
The technology is based on oxide layers deposited by reactive sputtering which are separated by an intermediate polymer layer.

The intermediate polymer layer consists of a novel inorganic-organic hybrid polymer, a so-called ORMOCER® (registered trademark of Fraunhofer-Gesellschaft), which is applied in a roll-to-roll process. ORMOCER®s are lacquers and can be processed under atmospheric conditions.

Their properties can be adapted to specific customer requirements by altering their chemical composition and process parameters. The intermediate layer interrupts defect growth in the oxide barrier layer and provides ideal conditions for deposition of the second oxide barrier layer.

A commercially available standard PET film was used as substrate. At 38°C and 90% relative humidity the coated film has a water vapor transmission rate of  $2 \times 10^{-4}$  g/(m<sup>2</sup>d).

The barrier layer system can be adapted to other substrates or according to specific customer requirements. For example, the film can be provided with a further protective layer or transparent conductive layer in order to use it as a substrate for (organic) electronic components such as organic light emitting diodes.



## Technology

The transparent inorganic barrier layers (Fraunhofer FEP) are deposited by using reactive dual magnetron sputtering in a roll-to-roll pilot plant.

After deposition of a barrier layer, the ORMOCER® intermediate and top layers (Fraunhofer ISC) are applied in a pilot plant using inverse gravure printing (Fraunhofer IVV). This process takes place under clean room conditions.

Thereafter, the second barrier layer and, if required, a transparent conductive layer are applied via magnetron sputtering.

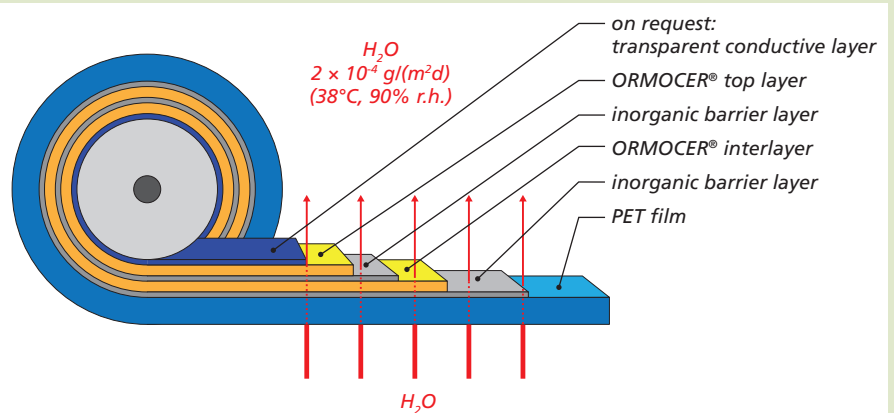
## Applications

The coated film can be used as a substrate for and encapsulation of E-paper, organic light emitting diodes, flexible solar cells, and LCD displays.

## Our offer

- sample coatings for evaluation of layer properties
- pilot production and supply of film rolls up to 500 m in length and up to 460 mm in width
- customer-specific adaptation of the barrier film (e.g. with a conductive top layer)
- advanced product-specific development of barrier films
- technology transfer and delivery of key components

## Scheme of transparent barrier film



## Properties

The key properties of the barrier are shown in the table. Comparative measurements with different analytical methods showed there was good reproducibility of the low water vapor transmission.

Properties	Value
substrate material	PET (Melinex 400 CW, 75 µm)
WVTR	< 5 × 10 <sup>-4</sup> g/(m <sup>2</sup> d)
at 38°C/ 90% r.h. (Aquatran)*	< 5 × 10 <sup>-4</sup> g/(m <sup>2</sup> d)
at 38°C/ 90% r.h. (HiBarSens®)*	4 × 10 <sup>-4</sup> g/(m <sup>2</sup> d)
at 38°C/ 90% r.h. (calcium mirror test)	2 × 10 <sup>-4</sup> g/(m <sup>2</sup> d)
at 23°C/ 50% r.h. (calcium mirror test)	8 × 10 <sup>-5</sup> g/(m <sup>2</sup> d)
OTR**	< 5 × 10 <sup>-3</sup> cm <sup>3</sup> /(m <sup>2</sup> d bar)
at 23°C / 0% r.h. (OX-TRAN 2/21)	(below measurement limit)
VLT*** (spectrum adaptable to application)	82%
roll width	max. 460 mm
roll length	max. 500 m

\*) The water vapor transmission rate was measured on a large area (≥ 100 cm<sup>2</sup>) at different positions on the film; \*\*) Oxygen transmission rate; \*\*\*) Visual light transmission

1 Roll-to-roll plant for coating with ORMOCER®

2 Roll-to-roll pilot plant (coFlex® 600) for inorganic barrier layer deposition