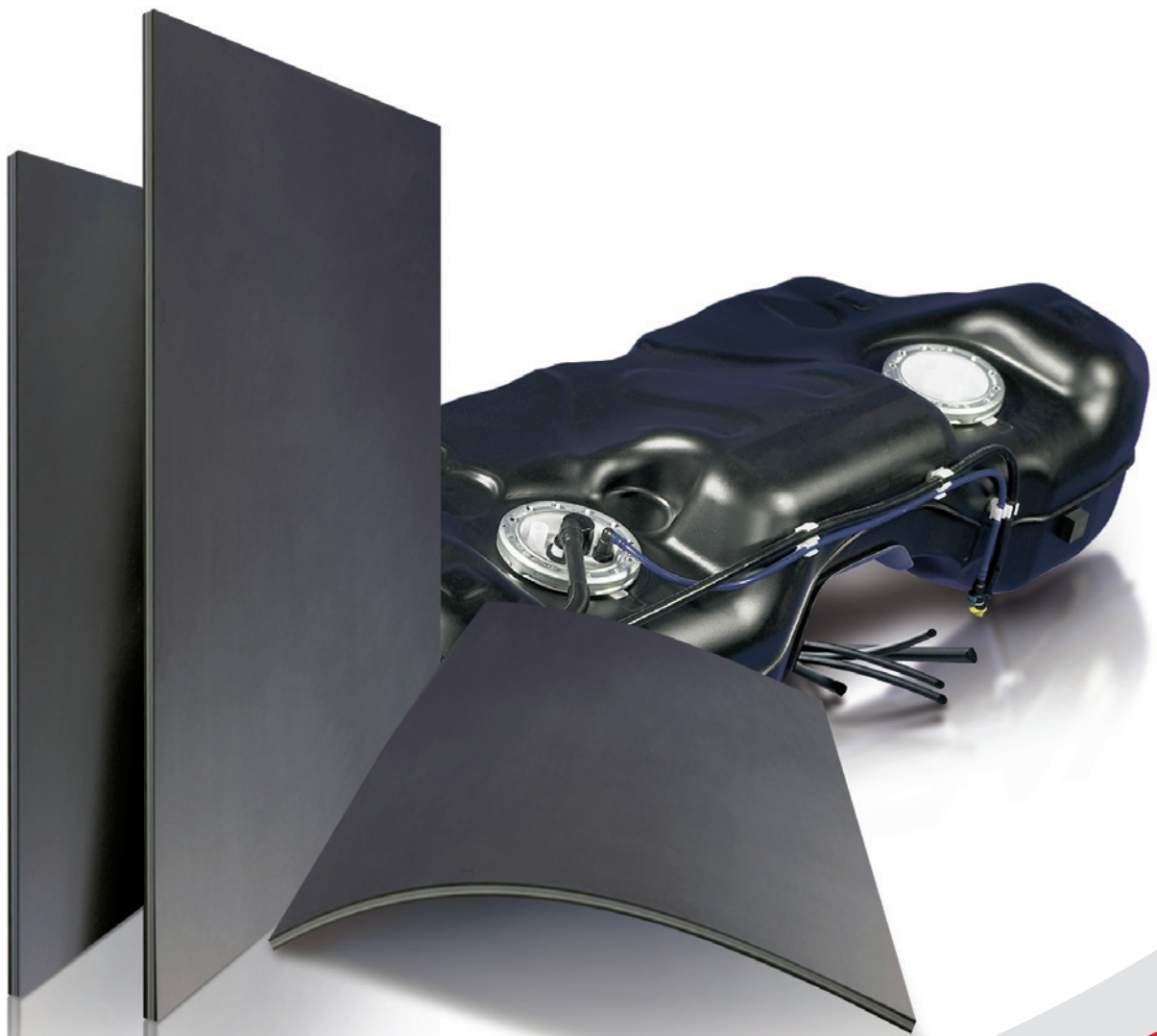


SIMONA



SIMONA® PE Multilayer Sheets

The Perfect Barrier Against Gases and Liquids

SIMONA® PE Multilayer Sheets – Semi-Finished Products with Integrated Barrier Layer



Benefits at a glance

- Excellent barrier against gases and liquids
- Corrosion-resistant
- High impact resistance and rigidity
- Physiologically safe
- Outstanding thermoforming properties
- Service temperature range from –50 °C to +80 °C
- Suitable for machine welding without impairing barrier properties

SIMONA® PE Multilayer Sheets are made of polyethylene and feature a barrier layer made of EVOH. Owing to their EVOH barrier against liquids and the excellent thermoforming properties of polyethylene, they open up new approaches to the design of industrial tanks for the purpose of storing and transporting liquid media such as fuels, solvents, chemicals and perfumes.

On account of their excellent barrier properties, SIMONA® PE Multilayer Sheets are also the perfect choice for the manufacture of state-of-the-art gas tanks. In addition, the excellent barrier provided by the EVOH layer provides a solid foundation when it comes to meeting future emission limits for fuel tanks.

Fields of application

- Fuel tanks
- Tanks for liquid media storage
- Thermoforming applications
- Gas tanks



The BMW X3 fuel tank made with SIMONA® PE Multilayer Sheets won the coveted Automotive Division Award.



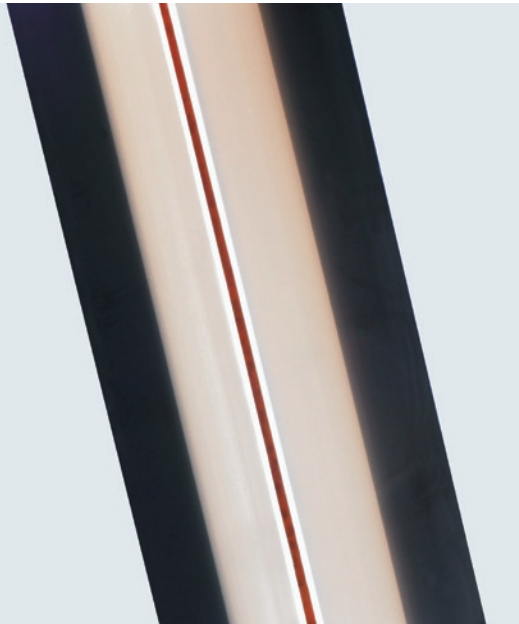
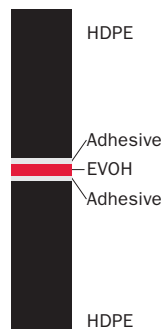
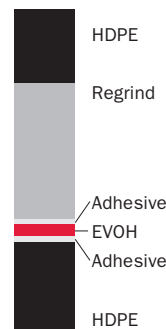


Figure 1: Examples of SIMONA® PE Multilayer Sheet design

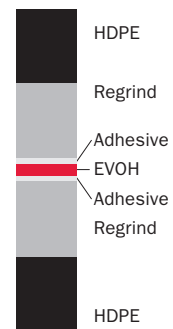
5-layer design



6-layer design



7-layer design



The design of SIMONA® PE Multilayer Sheets

SIMONA® PE Multilayer Sheets consist of two high-density polyethylene outer layers (PE-HD), an ethylene vinyl alcohol (EVOH) barrier layer to prevent diffusion and adhesive layers on both sides (Figure 1). These two adhesive layers are needed because the barrier plastic, EVOH, has no natural adhesion with PE. In principle, EVOH can be replaced by other barrier materials.

The layer design of SIMONA® PE Multilayer Sheets can be tailored to suit requirements, i.e. it is possible to incorporate different numbers of layers and different layer thicknesses.

Any off-cut materials can be regranulated and, based on a defined materials cycle, used as a regrind layer in sheet layer design. The regrind can be incorporated either as a single layer on the external wall or as a layer on both sides of the diffusion barrier.

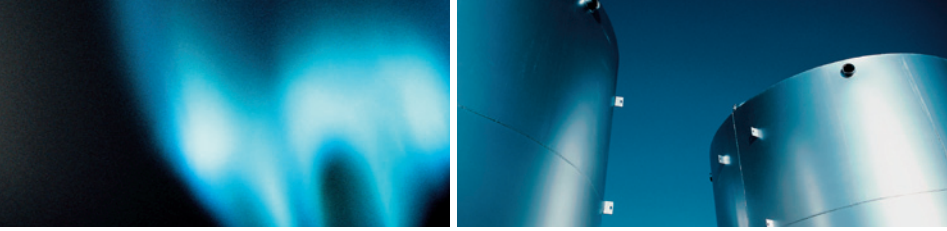
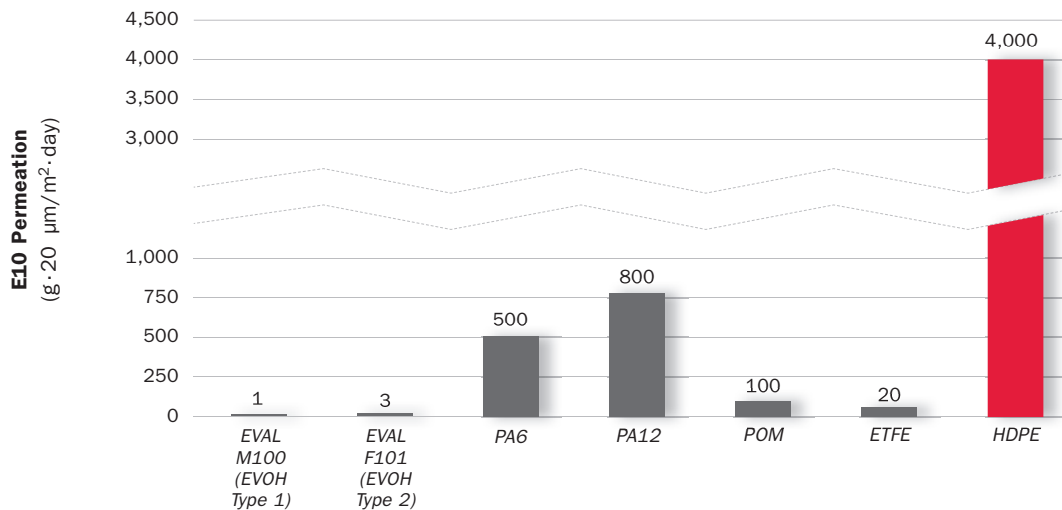


Figure 2: E10 barrier layers made of different materials for comparison (GC-based method)



EVOH – the barrier plastic

EVOH is among the most well-known barrier plastics. Classified as a statistical copolymer, it consists of ethylene and vinyl alcohol. The partially crystalline polymer features outstanding barrier properties and excellent thermo-plastic fabrication capabilities. The full range of fabrication processes such as extrusion, injection moulding and extrusion blow-moulding are possible. The lower the proportion of ethylene, the lower the fabrication capability and flexibility, but the higher the barrier against gases and liquids.

Even a small layer thickness of just a few µm is sufficient to create a barrier. EVOH can be combined with all the common plastics such as PE, PP, PS, PET and PC using an adhesion-promoting intermediate layer. Polyamide, on the other hand, joins with EVOH at extrusion temperatures without any adhesive.

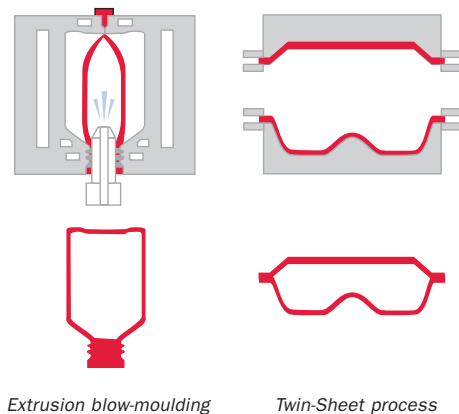
The barrier plastic, EVOH, is resistant to all types of oil, organic solvents, fuels, crop protection products, pesticides, many gases such as oxygen and hydrogen, but also odours and aromas.

In modern plastic fuel tanks the EVOH layer ensures compliance with the particularly stringent European and US emission standards for fuels. Figure 2 illustrates permeation of a fuel with 10% ethanol (E10) using different plastics. An EVAL M100 barrier against hydrocarbons is 4,000 times better than HDPE. A barrier against hydrogen, on the other hand, is 1,000 times better than PP.

Tank Manufacture with SIMONA® PE Multilayer Sheets



Figure 3:
Diagrams of production processes



Blow-moulded tank shells

Extrusion blow-moulding is the most commonly used production method for the manufacture of PE fuel tanks. This process involves extruding a plastic hose preform, or parison. Air is pumped into the hose through an extruder core until the hose has expanded to fit the tank shape of the blow mould. Service holes are then cut in the blow-moulded tank, through which the fuel pump, level sensors and possibly valves are inserted. When the components have been fitted, the holes are either closed off by welding or – in the case of serv-

ice holes – provided with sealed screw caps. The process of introducing components to the tank afterwards is cost-intensive and leads to potential leaks.

Twin-sheet process

In the twin-sheet process the tank is made from two thermoformed PE Multilayer Sheets. The process was refined by Visteon and Delphi for the manufacture of automotive fuel tanks in order to improve protection against leaks. The major advantage of the twin-sheet process is that components can be positioned in the tank in the best possible

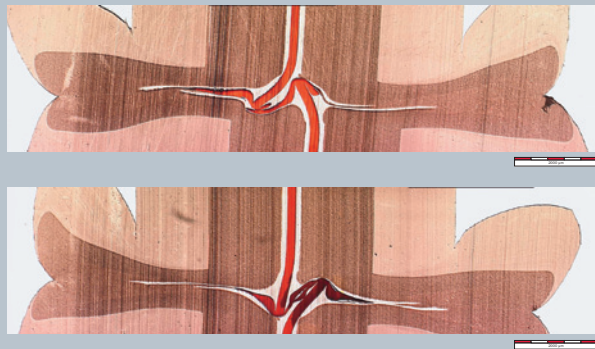
manner before the two halves of the tank are welded together. With this method, there is virtually no need to cut service holes in the tank wall.

CARB-compliant

Tanks of appropriate design manufactured by means of the twin-sheet process meet strict CARB emission limits (California Air Resources Board) and represent a global benchmark. By definition, only 0.054 g/d hydrocarbon emissions may be attributable to the fuel tank system.

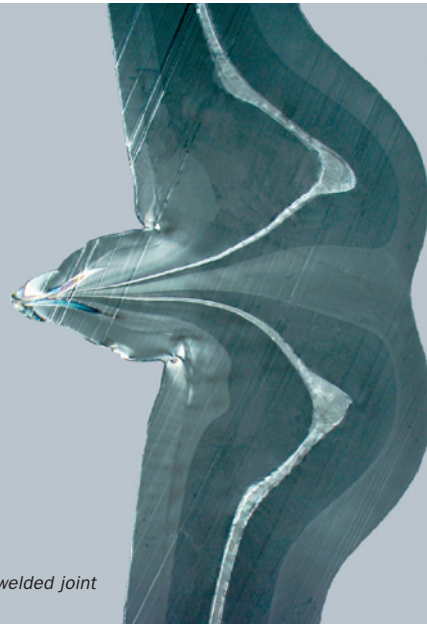
Welding of SIMONA® PE Multilayer Sheets

Figure 4: Joining two 7-layer sheets by butt welding and mash seem-welding



Butt-welded joint

Mash seem-welded joint



Welding methods for SIMONA® PE Multilayer Sheets

Connection technology plays a crucial role if the barrier is also to be maintained throughout joints. In addition to mash seem-welding, methods such as lap-welding and heated-tool butt welding can also be used. In the case of automotive fuel tanks manufactured on the basis of the twin-sheet or blow-moulding process, mash seem-welding is the method of choice.

In mash seem-welding the centre barrier layer can be identified as a light-coloured stripe with adhesive surrounding it. Owing to the geometry of the welding tool, the sheets are squeezed to such an extent that a small amount of material flows out of the zone of the mash-seem edge into the appropriately designed tool (in this case: to the left).


Pressure and temperature are selected so that an integral join is made between the two sheets.

The barrier layers of the two multilayer sheets flow to the left margin and merge almost completely. The layer thickness is thus reduced from approx. 250 µm to just a few µm. As a result, the distance between the two EVOH layers is only a few micrometres at the tapered end. Measurements and computer simulations have demonstrated that permeation through the very narrow gap between the two EVOH layers is much lower than through any other area of the fuel tank surface.

Product Range and Material Specifications

Range of products

SIMONA® PE Multilayer Sheets

	Material	PE-HD, EVOH barrier layer, Adhesive
	Colour	Outer layers black or natural
	Thicknesses	2 to 10 mm
	Width	2400 mm max.
	Layer design	5 to 7 layers, layer thicknesses variable
	EVOH layer thickness	1 to 10 per cent of total thickness

Other material combinations and colours require specific testing.



Material specifications

SIMONA® PE Multilayer Sheets

Density (integral), g/cm ³ ISO 1183	0.960
Yield stress, MPa DIN EN ISO 527	26
Elongation at yield, % DIN EN ISO 527	9
Elongation at break, % DIN EN ISO 527	200
Tensile modulus of elasticity, MPa DIN EN ISO 527	1100
Impact strength at -30 °C, kJ/m ² DIN EN ISO 179	no break
Shore hardness D, ISO 868	63
Adhesive strength of the layers, MPa EN ISO 291	> 3
Surface resistivity, Ohm DIN IEC 93	> 10 ¹⁴
Fire rating DIN 4102	normal flammability
Physiological safety, BfR	yes
Temperature range, °C	-50 to +80

The figures are approximate and may vary depending on fabrication processes and how test specimens are made. Unless indicated otherwise, the figures are averages of measurements on extruded sheets with a thickness of 6.5 mm. Please be advised that the processing company or user is responsible for testing whether our materials are suitable for a particular application.

Further information

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Put your trust in quality and expertise

SIMONA is able to offer you the most extensive range of semi-finished thermoplastics worldwide. Our comprehensive portfolio of products encompasses pipes, fittings, valves, sheets, rods, profiles, welding rods and finished parts for a diverse range of applications.

Our products and services are designed to deliver the very best quality imaginable. SIMONA AG's Quality Management system relating to the manufacture of multilayer sheets for the automotive industry is certified to ISO/TS 16949 : 2008.



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