SIMONA

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SIMONA® PE FOAM/SIMONA® PP FOAM

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Contents

1 General

The products SIMONA® PE FOAM and SIMONA® PP FOAM are foamed polyolefin sheets.

The foaming of plastics is a process that has been known for over 35 years (e.g. “polystyrene”, packaging materials, etc.) and is widely used in the area of PVC foam. SIMONA also applies it to the polyolefin materials PE-HD and PP-H, a segment in which our method has become well established. The resulting newly developed products SIMONA® PE FOAM and SIMONA® PP FOAM have a higher level of material efficiency, i.e. lighter weight and only slightly less rigidity than in the case of compact material. They have a higher level of thermal insulation, less distortion tendency and – compared to compact sheets – reduced internal stresses due to less material input.

1.1 Properties of SIMONA® PE FOAM and SIMONA® PP FOAM

Owing to their closed-cell foam core and their co-extruded outer skins made of compact material, SIMONA® PE FOAM and SIMONA® PP FOAM sheets provide an excellent ratio between low density, excellent surface quality and high flexural strength. SIMONA® PE FOAM and SIMONA® PP FOAM sheets combine two properties which are generally considered opposites: high strength and light weight.

Material properties

- Low density and high surface hardness
- High specific flexural strength
- Easy to clean
- Very easy to process
- Chemically resistant surface
- Corrosion-free
- Printable after pretreatment
- UV-resistant (SIMONA® PE FOAM)

1.2 Applications of SIMONA® PE FOAM and SIMONA® PP FOAM

SIMONA® PE FOAM

With SIMONA® PE FOAM it is possible to replace many components made of plywood and MDF. Compared to wood-based materials, SIMONA® PE FOAM is much more durable, especially in applications exposed to moist/wet conditions. Users also benefit from versatility in fabrication, high surface quality in an embossed finish and low water absorption.

SIMONA® PE FOAM is provided with UV stabilisation for outdoor applications as standard.

Examples of applications for SIMONA® PE FOAM

- Boatbuilding (partitions, bulkheads, control desks, etc.)
- Banner material
- Toilet containers, toilet walls and toilet doors
- Partitions in agriculture and livestock farming

SIMONA® PP FOAM

SIMONA® PP FOAM sheets have smooth, compact surfaces and exhibit higher flexural strength than SIMONA® PE FOAM sheets on account of the material. SIMONA® PP FOAM sheets are also very easy to process, have extremely low water absorption and are used for applications with non-critical chemical and mechanical stresses in apparatus construction, for example.

Examples of applications for SIMONA® PP FOAM

- Construction of small sewage treatment plants
- Apparatus components
- Tank covers
- Encasements
- Linings
- Packaging systems
- Insulation components
- Reusable containers
- Transport containers

2 Product Range of SIMONA® PE FOAM and SIMONA® PP FOAM

Product Range (dimensions in mm)

	SIMONA® PE FOAM	SIMONA® PP FOAM
Extruded sheets (formats/thicknesses)		
2000 x 1000	6, 8, 10	5, 6, 8, 10, 15, 20
2000 x 1250	10	–
3000 x 1500	–	5, 6, 8, 10, 15, 20
Standard colour	white	grey

For further information about our product range and the stock availability of products, please refer to our company website at www.simona.de or to our flyer “SIMONA® PE FOAM/SIMONA® PP FOAM”. Other colours and formats are available on request.

3 Technical Information

3.1 Material Specifications

Material specifications

		SIMONA® PE FOAM	SIMONA® PP FOAM
Density, g/cm³, DIN EN ISO 1183		0.700	0.650
Tensile modulus of elasticity, MPa, DIN EN ISO 527		700	1100
Impact strength, kJ/m², DIN EN ISO 179		without break	without break
Shore hardness D, DIN EN ISO 868		61	71
Mean coefficient of linear thermal expansion, K^{-1}, DIN 53752		1.8×10^{-4}	1.6×10^{-4}
Fire behaviour, DIN 4102		normal flammability	normal flammability
Temperature range, °C		−50 to +80	0 to +100
Physiologically safe	BfR	✔	✔
	EU	✔	✔
	FDA		✔

3.2 Fire Behaviour

The raw materials used for SIMONA® PE FOAM and SIMONA® PP FOAM have normal flammability (B2) in accordance with DIN 4102.

3.3 Performance in Outdoor Use

SIMONA® PE FOAM is a white, UV-stabilised PE foam that was designed and developed for outdoor applications. SIMONA® PP FOAM is not specially stabilised for outdoor applications.

3.4 Physiological Safety

According to Recommendation III by the German “Federal Institute for Risk Assessment” (BfR, previously BgVV), there are no reservations about using SIMONA® PE FOAM or SIMONA® PP FOAM for manufacturing commodities as defined by Section 2, paragraph 6, no. 1 of the German Food, Commodities and Feedstuffs Act (LFGB, as amended by an Announcement on 26 April 2006 in the German Federal Gazette I, p. 945).

All the monomers and additives used are listed in European Directive 2002/72/EC and addenda.

SIMONA® PE FOAM sheets are suitable for perimeter boards and for separating playgrounds in accordance with EN 71-3.

Furthermore, SIMONA® PP FOAM is manufactured from raw materials that meet the requirements of the “Food and Drug Administration” (Code of Federal Regulations, title 21, chapter 1, part 177.1520) for contact with foods.

3.5 Chemical Resistance

The non-polar nature of sheets made of SIMONA® PE FOAM and SIMONA® PP FOAM provides a high level of chemical resistance to:

- Salts (aqueous solutions)
- Acids
- Alkalis
- Alcohols
- Many solvents
- Fats
- Oils
- Waxes

Continuous contact with the aforementioned media may result in a small amount of swelling. However, this does not generally affect the service capability of these materials.

There is limited chemical resistance (swelling) to:

- Aromatic compounds
- Halogenated hydrocarbons

No chemical resistance to strong oxidants such as:

- Nitric acid
- Chromic acid
- Halogens

There is a higher risk of stress cracks, especially in the region of welds.

3.6 Water Absorption

SIMONA® PE FOAM and SIMONA® PP FOAM are closed-cell foam sheets, i.e. they only absorb negligible quantities of water and do not swell when immersed in water.

3.7 Temperature Range

The service temperature ranges of SIMONA® PE FOAM and SIMONA® PP FOAM are as follows*:

Temperature ranges

	SIMONA® PE FOAM	**SIMONA® PP FOAM**
Continuous service temperature	–50 °C to +70 °C	0 °C to +80 °C
Without any significant mechanical stress in air as the ambient medium	up to +80 °C	up to +100 °C
Crystalline melting temperature	approx. +130 °C	approx. +160 °C

*The above figures do not apply to applications in tanks – such cases are subject to special design rules that have to be agreed on an individual basis.

3.8 Resistance to Microorganisms

SIMONA® PE FOAM and SIMONA® PP FOAM do not constitute a source of nutrition for:

- Microorganisms
- Bacteria
- Fungus
- Spores
- Gnawing insects
- Rodents (gnawing may occur)

3.9 Health Aspects

As far as their chemical composition is concerned, SIMONA® PE FOAM and SIMONA® PP FOAM are essentially only made of carbon and hydrogen. When they burn – provided there is a supply of atmospheric oxygen – virtually the only substances that develop are carbon dioxide, carbon monoxide and water, accompanied by very small quantities of soot and low-molecular volumes of the relevant plastics. The ratio of carbon dioxide to carbon monoxide largely depends on the circumstances of burning – temperature, ventilation and an unobstructed supply of atmospheric oxygen. Consequently, burning fumes develop that resemble those of wood or stearin.

In the debate about the potential toxicity of fumes from burning plastics the fact that all burning fumes have a toxic effect is generally overlooked. Therefore, any claim that plastics exposed to fire develop particularly toxic gases is incorrect.

The most suitable extinguishant to combat burning SIMONA® PE FOAM and SIMONA® PP FOAM sheets is water or sand.

4 Processing Information

4.1 Machining

SIMONA® PE FOAM and SIMONA® PP FOAM can be processed by means of various methods. These include drilling, milling, turning and sawing; in this case, a distinction must be made between circular sawing and band-sawing. Water-jet cutting is also possible. For further information, please refer to our work.info "Machining".

4.2 Welding

4.2.1 General

The term plastic welding means the permanent joining of thermoplastics by applying heat and pressure, with or without the use of an additional substance. All welding processes take place when the materials in the boundary areas of the surfaces being joined are in a ductile state. That is where the threadlike molecules of the parts being joined and pressed together link up and entwine themselves to form a homogeneous material bond. Only plastics of the same kind, e.g. PP and PP, and within these types only those with the same or a similar/adjacent molecular weight and the same density, can be welded to one another; colour does not have to be taken into account.

SIMONA® PE FOAM and PP FOAM can be welded to one another without any reservations using conventional welding rods. Sheets and welding rods conform to the DVS Guideline and DIN EN ISO 1133 and have an MFR (= Melt Flow Rate) of 0.3 to 1.7 g/10 min or 0.2 to 0.7 (for PE) and 0.4 to 1.0 g/10 min (for PP) respectively. These figures were determined at 190 °C/5 kg. The materials may therefore be regarded as weldable.

4.2.2 Welding Preparation

Directly before welding the surfaces to be connected, the adjacent areas and any damaged surfaces (especially if there are weather or chemical influences) must be machined down to intact zones. Dirt, grease, hand sweat and oxide layers must be removed by machining in order to obtain a high weld factor. Detergents that attack or alter the plastic surface must not be used.

4.2.3 Hot Gas Draw Welding

For sheets that can only be welded from one side it is advisable to use a single V. Cleaning of surfaces to be welded on sheet and welding rod by machining is essential. Welding with the tacking nozzle serves to keep the parts in position. Fusion is performed with hot air but without any additional welding rod.

Recommended figures for hot gas draw welding

Material	Air	Temperature	Speed cm/min			
		5 mm measured in the welding nozzle	Fan-welding nozzle		High-speed welding nozzle	
	l/min	°C	3 mm	4 mm	3 mm	4 mm
PE FOAM	50–60	300–340	10–15	approx. 10	≤50	≤40
PP FOAM	50–60	300–340	approx. 10	<10	≤50	≤40

4.2.4 Extrusion Welding

Extrusion welding is another method of connecting SIMONA® PE FOAM and SIMONA® PP FOAM to one another. In this case, a standard welding rod made of compact material has to be used (for preparation, see 4.2.2).

The recommended figures for air temperature, mass temperature and air flow are as follows:

Recommended figures

	Mass temperature °C	Air temperature °C	Air flow l/min
PE FOAM	210–230	250–300	≥300
PP FOAM	210–240	250–300	≥300

4.2.5 Heated Element Butt Welding

Warming is performed by a coated (PTFE) heated element. Owing to the direct contact, the transmission of heat is far more intense than with hot gas draw welding or extrusion welding; the distribution of heat over the cross-section of the material is more efficient. Thus, there is no zone in the material which is subjected to a higher thermal load than that required for welding. That means the stress to which the joints are subjected is very low. In heated element butt welding the welding process takes place when the heated surfaces of contact are brought together at a specific pressure and allowed to cool down under pressure. Modern equipment is provided with a data collection feature that makes it possible to store welding parameters and print out welding records.

The quality of seams depends on the following criteria:

- The cleanliness of the parts to be joined by welding and of the heated element itself is of paramount importance in heated element butt welding.
- Teflon films or coatings facilitate the cleaning of heating surfaces and prevent plastics from clinging to the heated element when warming up.

Internal tests have shown that compared to compact materials the higher alignment and joining pressures with foamed materials lead to better welding results.

Recommended figures for heated element butt welding on sheets made of SIMONA® PE FOAM

Sheet thickness	Temperature	Alignment* p ≈ 0.30 N/mm²	Heating-up p ≈ 0.01 N/mm²	Change-over	Joining p ≈ 0.30 N/mm²	
		Bead height	Time	Max. time **	Joining pressure build-up time	Cooling time under joining pressure
mm	°C	mm	s	s	s	min
6	215	1.0	60	< 3	5.5	8.5
8	215	1.5	80	< 3	6.5	11.0
10	215	1.5	100	< 3	7.0	12.5
12	210	2.0	120	< 3	8.0	16.0
15	210	2.0	150	< 3	8.5	19.5
20	205	2.0	200	< 3	10.5	25.0

* Bead height at the heated element at the end of alignment time (alignment under 0.3 N/mm²)
** Change-over time must be kept as short as possible; otherwise the plasticized surfaces will become cold.

Recommended figures for heated element butt welding on sheets made of SIMONA® PP FOAM

Sheet thickness	Temperature	Alignment* p ≈ 0.20 N/mm²	Heating-up p ≈ 0.01 N/mm²	Change-over	Joining p ≈ 0.20 N/mm² ± 0.01	
		Bead height	Time	Max. time **	Joining pressure build-up time	Cooling time under joining pressure
mm	°C	mm	s	s	s	min
6	215	0.5	160	< 3	5–6	6 – 12
8	215	1.0	190	< 3	6–8	12–20
10	215	1.0	215	< 3	6–8	12–20
12	210	1.0	245	< 3	8–11	20–30
15	210	1.0	280	< 3	8–11	20–30
20	205	1.5	340	< 3	11–14	30–40

* Bead height at the heated element at the end of alignment time (alignment under 0.2 N/mm²)
** Change-over time must be kept as short as possible; otherwise the plasticized surfaces will become cold.

For further and more detailed information on the subject of welding, please refer to our work.info “Welding”.

4.3 Thermoforming

In single-stage thermoforming processes a basic distinction is made between male and female forming.

Recommended figures for thermoforming SIMONA materials

Material	**Name**	**Maximum stretch ratio** ①⑤	**Shrinkage in extrusion direction** ② in %		**Processing temperature** ③ in °C	**Mould temperature** in °C
			Forming			
			Male	Female		
PE-HD/PE 80	PE-HWU/PE-HWST	1 : 4	2–3	> 3	160–180	50–70
	PE-HWV④	1 : 5				
	PE-EL	1 : 3.5				
	PE FOAM	1 : 2	–	–	160–180	50–70
PP	PP-DWU/PP-DWST/PPs	1 : 3	1.5–2.5	> 2.5	170–200	50–80
	PP FOAM	1 : 2	–	–	170–200	50–80

① Ratio of sheet area to moulding area
② Approx. half the figure in the transverse direction
③ Surface temperature, not radiant heater temperature
④ For extreme stretch ratios, specifically for female forming
⑤ Depends on operating staff and system

The figures are values determined by experiment using a thermoforming unit from Illig, Type U100, with ceramic radiant heaters. The temperatures of the top heater were 550/500/450 °C. The temperature of the bottom heater was 400 °C.

Any decision whether to use male or female forming depends on the result that has to be achieved by the moulding. In the case of male forming, for example, shaping precision is achieved on the inside because the inside of the semi-finished product makes contact with the mould. In addition, the mould surface is reproduced very well on the side making contact.

Wall thickness distribution is also very different. Wherever a thin area occurs in male forming a thick area is created in female forming.

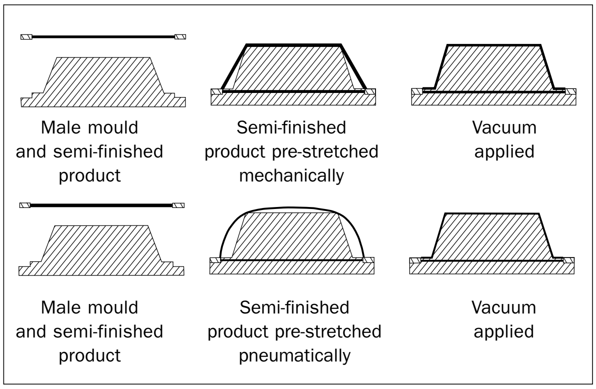

Fig. 1: Diagram of male forming.

Mould textures and production data can be reproduced very well on the part, the best results being achieved with PP. If specified tolerances are limited, male forming has to be used because the part shrinks onto the mould when it cools down. This restricts the amount of shrinkage.

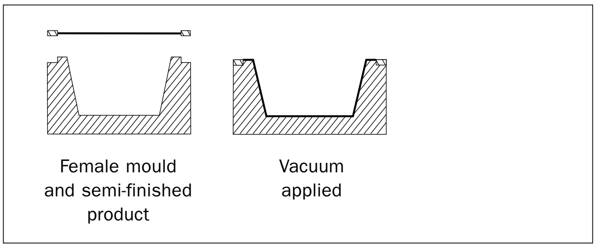

Fig. 2: Diagram of female forming without any mechanical or pneumatic pre-stretching.

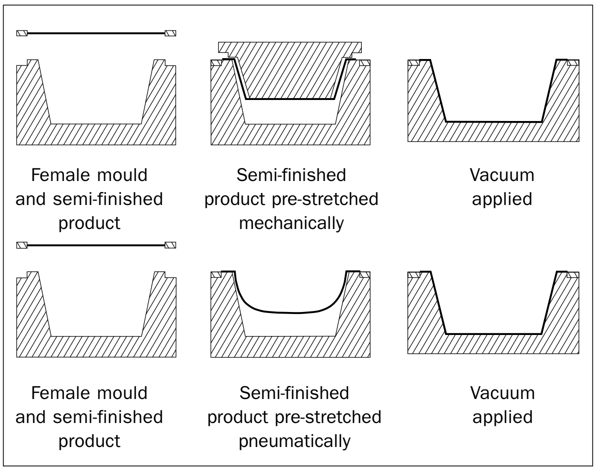

Fig. 3: Diagram of female forming with mechanical or pneumatic pre-stretching.

As soon as the material is completely plasticized, it should pre-blow – in the mould – to an appropriate height (or else there will be a risk of wrinkling) or pre-stretch in the case of female forming. Pre-stretching should take place at approximately ²⁄₃ of the height of the mould. After that, the mould is moved into the pre-stretched sheet and the vacuum is applied. In areas where the plastic makes contact with the mould any further forming is restricted owing to the rapid cooling.

Air should preferably be used for the subsequent cooling process. The use of spray water should only take place when the surface has cooled down sufficiently in order to prevent stresses from being frozen into the material. This method of processing makes wall thicknesses more uniform and reduces internal stresses.

For economical production of top-quality thermoformed products made of polyethylene and polypropylene it is advisable to allow the part to cool down completely.

High forming temperatures, slow cooling rates, preferably low demoulding temperatures and edge trimming that directly follows the thermoforming process all help to reduce distortion.

5 Structural Analyses

In terms of their characteristics, sheets made of SIMONA® PE FOAM and SIMONA® PP FOAM do not conform to DVS Guideline 2205, which is why no normal tank analyses are made available for said materials.

6 Legal Note and Advice

Legal Note

Upon publication of a new edition all previous editions shall become void. The authoritative version of this publication can be found on our website at www.simona.de.

All information furnished in this publication reflects our current scope of knowledge on the date of publication and is designed to provide details of our products and potential fields of application (errors and omissions excepted, including typographical mistakes). This shall not be deemed as constituting the provision of legally binding guarantees or warranties as to specific properties of the products or their suitability for specific areas of application.

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Our sales staff and members of the Technical Service Center look forward to advising you on all issues relating to the processing and application of semi-finished thermoplastics.

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