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Product Information

09/99

Electrically conductive semi-finished products

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Advice

General information

Solids and liquids can charge electrostatically through friction.

As a result unloading may produce sparks which can ignite explosive materials (solid, liquid or gaseous).

SIMONA® EL-plastics present no such problems. These electrically conductive grades prevent electrostatic build-up. Examples of applications are:

- ▶ Packings and linings for flammable liquids
- ▶ Pipe lines for the transport of combustible liquids, solvents and vapours as well as their mixtures
- ▶ Laboratory exhaust ducts
- ▶ Packings and transport pallets for fragile products

In connection with combustible materials an authorization may be necessary.

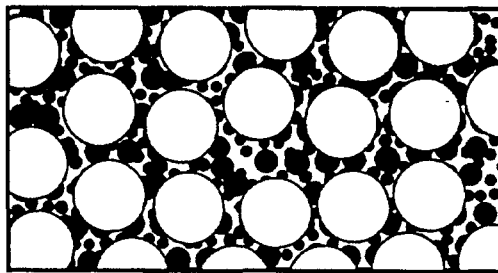
Electrostatic charge and electric conductivity

Electrostatic build up can occur with:

1. solid materials with a surface resistance of more than 10^9 Ohm (DIN 53486/VDE 0303, part 8).
2. liquids with a specific resistance of 10^8 Ohm · m (measured according to DIN 51 412/VDE 0303, part 3).
3. unearthed object from conductive materials

Generally, plastics are good insulators. Conductive particles are added to draw out the electrical charge. SIMONA® EL-plastics are mixed with special carbon blacks in order to achieve as small a surface resistance as possible.

Distribution of carbon black in SIMONA® PE-EL-sheets which are modified for electrical conductivity (schematic)



Processing effects

Conductive properties largely depend on the orientation of the individual particles of the conductive filler. Since such particles generally do not have an ideal, spherical shape, such parts are orientated in a plastic melt, e. g. at extrusion, in the direction of flow.

Isotropically distributed particles distribute conductivity uniformly in all directions. Orientated particles generally conduct in the direction of orientation, but offer poorer conductivity than isotropically distributed particles. Various tests with extruded EL-semi-finished products of SIMONA show however an only small influence of the manufacturing process on the conductive behaviour of the semi-finished product. Pressed SIMONA*

PE-EL sheets show an isotropic behaviour and, accordingly, a more homogenous electrical conductivity than extruded sheets and pipes.

Measurement of the surface and volume resistance

(DIN IEC 167, DIN IEC 93)

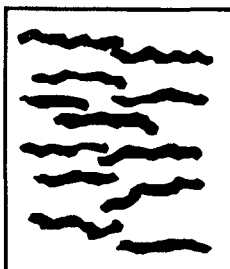
The result of measurements of the electrical resistance (surface and volume resistance) is decisively influenced by several variables.

The „connection“ of the measuring electrode to the surface of the semi-finished product is an important factor for an exact measurement of the electrical resistance. Measuring errors of the order of approximately 10,000 Ohm may occur through the use of unsuitable electrodes. Hence we recommend to use adhesive

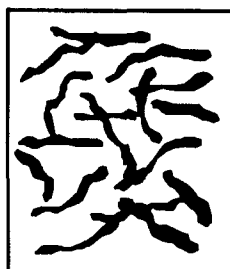
electrodes consisting of conductive silver which guarantee a good connection and reproducible results.

The measured values of the resistance can be considerably increased through a mechanical treatment, e. g. wrinkling of surface, so that after checking the finished construction a larger distance between the electrodes might be preferred.

Effect of the processing method on the carbon black orientation (schematic)



orientation
(e.g. extruded sheet)



no orientation
(Isotropy)
(e.g. pressed sheet)

Characteristic features

SIMONA® PE-EL

- ▶ High chemical resistance
- ▶ Good UV-resistance
- ▶ Application in a temperature range of -50 up to +80 °C
- ▶ Good impact resistance
- ▶ Normally inflammable
- ▶ Can be welded
- ▶ Can be thermoformed
- ▶ Can be vacuum formed

SIMONA® PP-EL

- ▶ High chemical resistance
- ▶ Satisfactory UV-resistance
- ▶ Application in a temperature range of 0 up to +100 °C
- ▶ Normally inflammable
- ▶ Can be welded
- ▶ Can be thermoformed
- ▶ Can be vacuum formed

SIMONA® PP-EL-S

Unlike PP-EL this material disposes of a flame resistant additive. With this it achieves a more favourable fire classification.

SIMONA® PP-EL-SK

These sheets are lined on one side with a stretch fabric of thermoplastic polyester for direct lamination of sandwich construction. Of course the conductivity refers only to the unlined side.

SIMONA® PVC-EL

- ▶ High chemical resistance
- ▶ Satisfactory UV-resistance
- ▶ Application in a temperature range of 0 up to +60 °C
- ▶ High rigidity
- ▶ Flame retardant
- ▶ Easy cutting processing
- ▶ Can be welded
- ▶ Can be thermoformed
- ▶ Can be vacuum formed
- ▶ Can be glued

SIMONA® PVDF-EL

- ▶ Excellent chemical resistance
- ▶ High UV-resistance
- ▶ Application in a temperature range of -50 up to +140 °C
- ▶ High rigidity, connected with high tenacity even at low temperatures
- ▶ Low flammability
- ▶ Can be welded
- ▶ Can be thermoformed
- ▶ Can be vacuum formed

SIMONA® PVDF-EL-CV

Semi-finished products with chemically pre-treated surface which allows a direct lamination in composite construction.

Examples of applications

- ▶ Packings and transport pallets
for dust-susceptible products to
avoid electrostatic charge
- ▶ Tanks with flammable liquids
- ▶ Pipe lines for the transport of
combustible liquids, solvents
and vapours as well as their
acid mixtures
- ▶ Laboratory exhaust ducts
- ▶ Transport pipes for flammable
gases
- ▶ Gas collecting mains for land
fill sites
- ▶ Container and machine parts in
explosion-proof rooms
- ▶ Lining of tanks for storing and
bottling of dustlike materials
- ▶ Offtakes in coal manufacturing
factories

Production range

The following SIMONA® EL-semi-finished products can be delivered as special design on request.

	PE-EL	PP-EL	PVC-EL	PVDF-EL
sheets				
pressed	10 - 80	10 - 80	--	--
extruded	2 - 12	2 - 12	1.5 - 10	2 - 6
solid rods	on request	on request	--	--
pipes	up to da 630	--	--	--
fittings	up to da 315	--	--	--
welding rod	2 - 4	on request	3 - 6	on request

also on request:

PP-EL-S, black, sheets extruded and pressed

PP-EL-SK, extruded, 3 - 6 mm

PVDF-EL-SK, 3 - 6 mm, PVDF-EL-GK

Our sales department will be pleased to answer further questions to the a/m dimensions.

Technical information

Characteristic values of material

	Test method	Dimension	PE-EL	PP-EL	PP-EL-S	PVC-EL	PVDF-EL	
Density	DIN 16776	g/cm ³	0.99	0.94	1.18	1.4	1.78	
E modulus at tensile test	DIN EN ISO 527	MPa	900	1400	1400	3000	1800	
Yield stress	DIN EN ISO 527	MPa	25	28	26	50	45	
Tensile strain at break	DIN EN ISO 527	%	30	45	50	15	20	
Impact strength	DIN EN ISO 179	kJ/m ²	without break					
Notched impact strength	DIN EN ISO 179	kJ/m ²	6	>4	>4	5	6	
Ball indent. hardn. H 358/30	DIN EN ISO 2039-1	N/mm ²	60	66	66	120	110	
Shore hardness D	ISO 868	-	63	72	70	81	78	
Vicat softening point B/50	DIN ISO 306	°C	--	--	--	78	132	
Mean linear expansion coefficient	DIN 53752	K-1	1.8·10 ⁻⁴	1.6·10 ⁻⁴	1.6·10 ⁻⁴	0.8·10 ⁻⁴	1.3·10 ⁻⁴	
Thermal conductivity *	DIN 52612	W/mK	0.38	--	--	0.159	0.14	
Volume resistivity (Annular electrode)	DIN IEC 93	Ohm · cm	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	
Surface resistance**	DIN IEC 167	Ohm	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	≤ 10 ⁶	
Water absorption	DIN 53495	%/24 h	< 0.006	< 0.02	< 0.02	0.03	0.02	

* measured on test pieces of 10 mm thickness

** electrode order B

These standard figures can vary according to the processing and production methods used.

The above characteristic values are obtained from 4 mm extruded sheets and can vary in other thicknesses. The suitability of our material for a specific application must be verified by the fabricator or user.

Designation of material

PVC-EL	extruded	PVC-U, EDLZ, 078-04-33	(DIN 7748, 9/85)
PE-EL	extruded	PE, ECYL, 45 T 003	(DIN 16776, 12/84)
	pressed	PE-QCYL, 45 T 003	(DIN 16776, 12/84)
PP-EL	extruded	PP-H, ECY, 95 T 006	(DIN 16774 T1, 12/84)
PP-EL-S	extruded	PP-H, ECFY, 95 T 006	(DIN 16774 T1, 12/84)

Physiological safety

SIMONA® EL-materials do not satisfy the requirements of the law governing foodstuffs and consumables, therefore direct contact with foodstuffs should be avoided.

Chemical resistance

SIMONA® EL-materials are - like the basic materials - resistant to many chemicals. Specific resistance depends on the medium, on the temperature and on the medium's concentration. Therefore, we recommend to contact our Technical Application Department, if required.

Outdoor use

In comparison to the standard products PE-HWU/PVDF, SIMONA® PE-EL/PVDF-EL show a similarly good UV-resistance. SIMONA® PP-EL, PP-EL-S and PVC-EL reach a sufficient UV-resistance during outdoor use by a modification of the conductive carbon black. It should be mentioned in this respect that SIMONA® PVC-EL should not be heated (absorption of sun rays) above 60 °C.

Processing

Humidity/Pretreatment

The carbon black added to the respective plastic tends - when stored for prolonged time or under unfavorable conditions - to absorb a small amount of humidity due to its chemical-physical properties. However, trials with PE-EL/PVDF-EL-samples, stored in water for a period of 14 days, showed no significant difference to the original samples when being processed. Pre-drying is recommendable as the adsorption of (atmospheric) humidity is influenced to a large extent by handling and logistic (see also product information „Welding“).

Welding/Thermoforming

The partially crystalline SIMONA® products PE-EL, PP-EL, PP-EL-S and PVDF-EL can be as easily welded as the analog basic materials. Values for short-term welding factors and bending angles which can be compared with those achieved with PE-HD (DVS guideline 2201, part 2) are reached especially at heated element butt welding (HS) and hot gas extrusion welding (WE) of SIMONA® PE-EL.

The conductive PP-grades, PVC-EL and PVDF-EL can also be perfectly joined by means of HS-, WE- and hot gas string-bead welding.

The mechanical short-term values of watered and HS-welded PE-EL/PVDF-EL-samples do not significantly differ from the untreated sample.

Due to the polar character of the basic material PVC/PVDF, the conductive grades PVC-EL/PVDF-EL may also tend to absorb water at extremely unfavourable (atmospheric) conditions.

Depending on the content of humidity, a formation of bubbles in the weld seam area or during vacuum-forming might occur. Therefore, pre-drying of SIMONA® EL-products could possibly be required.

Processing parameters and measured values of resistance

SIMONA® EL-semi-finished products principally can be welded with the same parameters as their basic materials. Exception: Please use special EL-welding wire for hot gas welding.

Further processing aids can be taken from our product information „Welding“ and „Vacuum-forming, Thermoforming, Bending“ or contact our Technical Application Department.

The surface or volume resistance (DIN IEC 167 and 93) of thermoformed and with same welding addition welded SIMONA® EL-materials can be compared with the measured values of untreated EL-semi-finished products. The excellent electric conductivity of SIMONA® EL-products remains even after processing with the well-known welding and forming methods. Strong orientation caused by forming can affect the electrical conductivity.

Information about security

Under the conditions indicated in this product information, the processing of SIMONA® PVDF-EL is not at all dangerous. Extensive measurements on the welding place have proved without doubt that no measureable concentrations of harmful substances occur. However, due to processing errors or breakdowns, the temperature of the material could exceed the critical limit of 350 °C. This can result in the production of hydrogen fluoride and/or related fluorine combinations.

To prevent this we ask you to observe the following rules:

1. Do not expose SIMONA® PVDF-EL to the naked flame.
2. Do not smoke in areas in which an accumulation of PVDF-dust can be expected.
3. Observe the recommended air and tool temperatures when welding; this prevents the exceeding of the critical temperature of 350 °C.

Advice

Our Export Department and Technical Application Department are long-experienced in the application and processing of thermoplastic semi-finished products. We look forward to helping you.