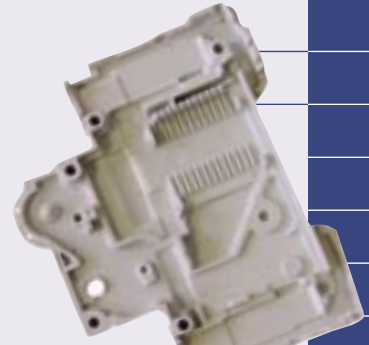
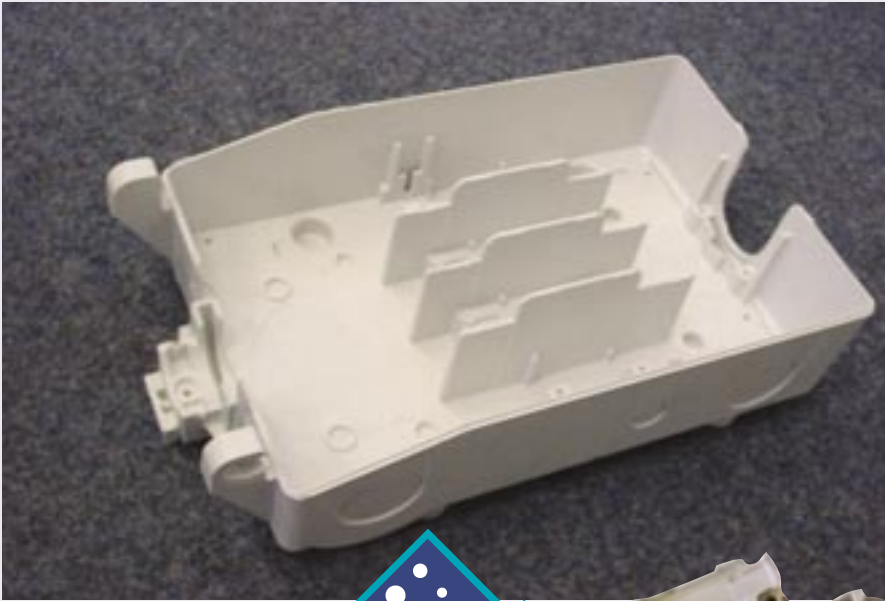




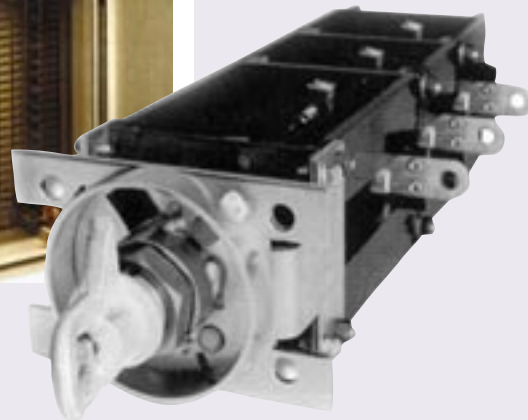
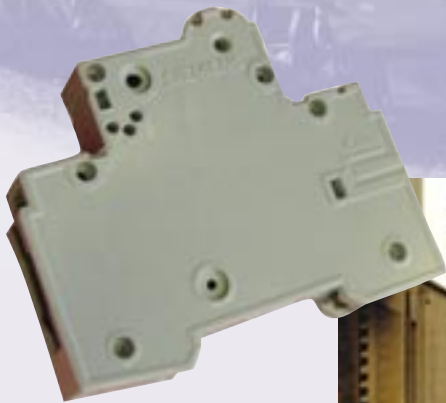
SMC/BMC and the Electrical Industry



European
Alliance
for SMC



SMC / BMC

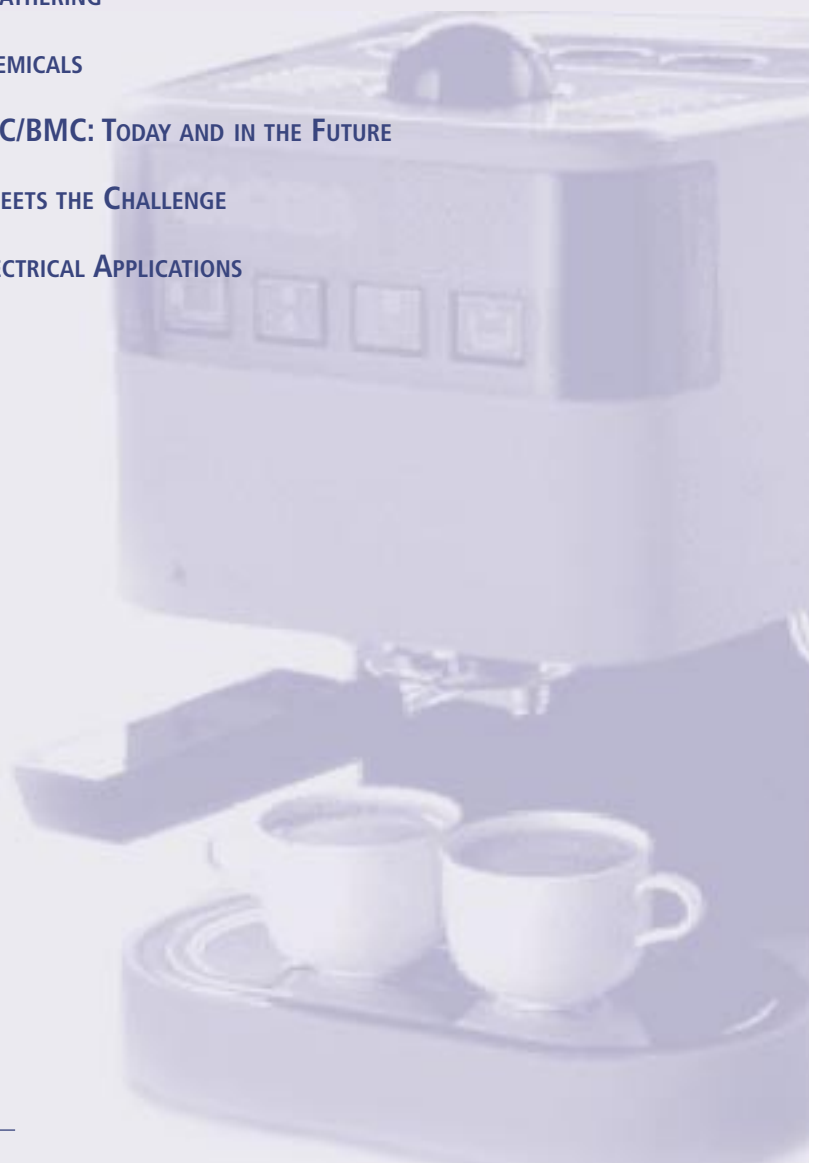


SMC/BMC

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THE EUROPEAN ALLIANCE FOR SMC

The European Alliance for SMC was formed in 1993 within the AVK (German Composites Association) by leading European companies. It represents a concerted commitment to the technological advancement of this material, members include:

- SMC manufacturers,
- SMC moulders/parts producers,
- UP resin suppliers,
- Producers of glassfibre reinforcements,
- Producers of additives.

All those involved in the SMC / BMC value chain decided to cooperate closely, with the principal objective being to hasten new developments.

SMC parts users will profit from the founding of the European Alliance for SMC and from the improved service it will bring, now that the market can be addressed by a single voice.

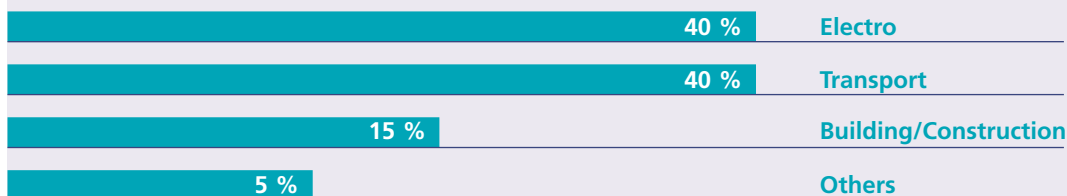
SMC PARTS USERS WILL REAP THE FOLLOWING BENEFITS:

- New innovative formulations,
- Proven material with over 35 years practical service life under the severest operating conditions,
- Specially formulated composite materials for leading edge applications, such as low density or halogen-free flame retardant parts,
- Systems for collecting and recycling used parts are operational.

The European market for fibre reinforced plastics has an annual volume of more than 1,3 million tonnes. SMC/BMC represents the biggest individual segment within this group of materials.

TOTAL SMC/BMC

EUROPEAN CONSUMPTION (2001) 280.000 TONNES



SMC/BMC

WHAT IS SMC/BMC?

SMC/BMC COMPOSITION.

SMC is a compounded, fibre reinforced composite material which primarily consists of a thermosetting resin, glass fibre reinforcement and filler.

Additional ingredients such as low-profile components, cure initiators, thickeners, process additives and mould release agents are used to enhance the performance or processing of the material.

SMC/BMC can be formulated to meet specific performance requirements of a particular application, such as fire retardancy, tensile loading or Class "A" surface finish.

The recipe can be formulated using different ingredients and combinations to match the end needs of the moulded part . For example the glass fibres in SMC are chopped into lengths from 12 mm to 50 mm (BMC: 6 to 12 mm), depending on the degree of mechanical strength needed. The amount can vary from 20 % to 60 % by weight (BMC: 10 % to 30 %). Trade-off is usually performance and processability versus cost.

If you want more information please order our manual "SMC/BMC: Design for Success" from the office of the European Alliance for SMC.



THE HISTORY OF THE MATERIAL

Moulded SMC/BMC parts are ideal for the electrical engineering industry. Great experience has been gained in the production of cabinets, switches, outdoor lamps, and other electrical applications.

In fact, the material has been in use longer than most other plastics. For instance, the first electrical cabinets were produced in 1963, and some of these are still in use.

Life spans of over 30 years for SMC/BMC electrical cabinets are not unusual. Such a service life has not been achieved with polycarbonate or other thermoplastics materials.

Since SMC was first commercialised, new improved resin systems have been developed and manufacturing procedures have been optimized to enable the production of high-quality electrical applications that fully exploit the many benefits of SMC.

DEMANDS ON MATERIALS

The production of parts for the electrical/electronic industry (E&E) is governed by various standards and regulations that specify which designs are permissible and how the production materials may be employed.

SMC represents the best compromise between the electrical, chemical, mechanical and process-control requirements. Looking at the properties listed below, it is easy to see why it has become so widely used.

Electrical insulation	Variable component thicknesses	Machine workability
Fire-resistance	Corrosion resistance	Recyclable
Dimensional stability	No painting necessary	Direct screw assembly, without previous threading
High temperature stability	Resistance to environmental effects	Permits direct integration of assembly points and inserts
Shock resistance	Life span	Cost/benefit factor
Mechanical strength	Creep resistance	Design freedom

No other material provides a comparable list of benefits.

MOULDING PROCESS SMC/BMC

COMPRESSION MOULDING PROCESS BMC AND SMC.

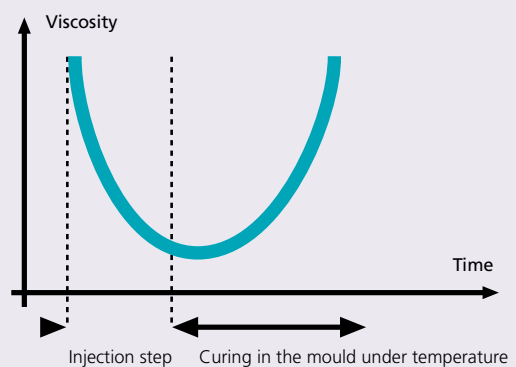
The compression moulding process is a well developed technique whereby the SMC or BMC is placed in a heated mould (150°C). The SMC heats up during the closing of the mould and so flows easily throughout the whole cavity.

INJECTION MOULDING OF BMC AND SMC.

The injection moulding process is a more recently developed technique whereby the BMC or SMC is injected into a heated mould (160°C). The BMC or SMC heats up during the injection and so flows easily into the cavity. Due to the special heating method the curing speed is somewhat faster than compression moulding so cycle time is generally quicker.

One of the advantages of BMC and SMC component design is that it enables great freedom in design style and functional integration. A single complex moulding can incorporate many parts and functions saving assembly time and costs.

For more detailed information see our Manual 'SMC/BMC Design for Success'.

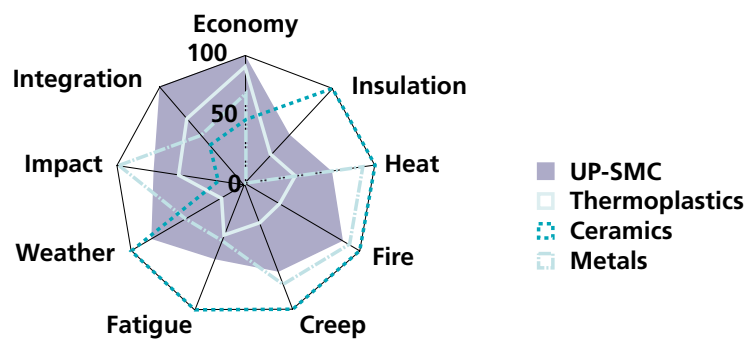


MATERIAL DATA

THE DATA SHEET BELOW IS A TYPICAL EXAMPLE OF AN ELECTRICAL APPLICATION.

CHARACTERISTIC VALUE	STANDARD	VALUE
Impact strength	ISO 179	> 60 kJ/m ²
Tensile strength	ISO 527	> 64 MPa
Tensile modulus	ISO 527	> 8,000 MPa
Flexural strength	ISO 178	> 160 MPa
Flexural modulus	ISO 178	> 8,500 MPa
Heat distortion temperature	ISO 75	> 200° C
Temperature range		- 50° C - 150° C
Water absorption	ISO 62	< 45 mg
Light fastness	DIN 53 388	7 - 8
Tropical and moisture resistance	IEC 68 - 2 - 5	No reduction in the mechanical and electrical properties
Fire resistance	UL 94	V-0 3.0 mm
Dielectric strength	IEC 243-1	> 18 kV/mm
Surface resistance	IEC 93	> 10 ¹² Ω
Tracking resistance	IEC 112	CTI 600

COMPARISON OF MATERIALS FOR E & E HOUSINGS



This material for electrical equipment is characterized by a balanced relationship between its mechanical, electrical and thermal properties. The formulations can be homogeneously coloured so that the components do not require painting. And the very good flow properties permit the manufacture of complex shapes.



RESISTANCE TO WEATHERING

A critical factor for materials used for electrical cabinets is their resistance to weathering. Such applications must not become defective even if exposed to the elements for prolonged periods of time. SMC/BMC has been used for electrical cabinets, for over 30 years. Most SMC/BMC electrical cabinets, lamp housings and other outdoor parts are self coloured and have not been painted or surface treated in any way: yet UV radiation, rain, wind and temperature fluctuations have not produced any adverse effects. Metal cabinets corrode, but SMC modules only show a slight yellowing, matting or surface abrasion over time.



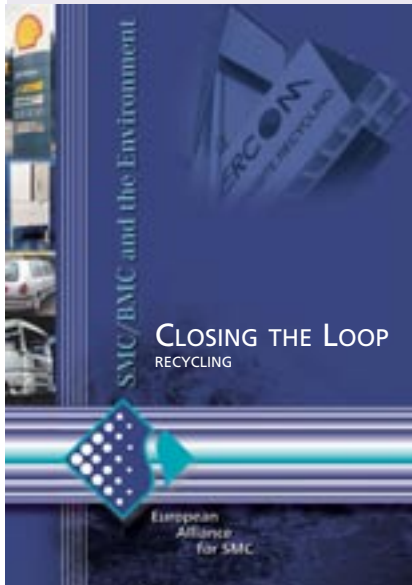
RESISTANCE TO CHEMICALS

Switch cabinets must be resistant to everyday chemicals. Many electrical cabinets and housings are erected close to roads or plants to house traffic-light or machine control systems. The following list of material resistance gives an overview of SMC's behaviour in common environments at ambient temperature.

ORGANIC MEDIA	RESISTANT	INORGANIC MEDIA	RESISTANT
Hot bitumen	Yes	Hydrochloric acid (10%)	Yes
Petrol	Yes	Phosphoric acid (10%)	Yes
Diesel oil	Yes	Phosphoric acid (85%)	Yes
Jet fuel (kerosene)	Yes	Sulphuric acid (10%)	Yes
Epoxy resin	Yes	Sulphuric acid (37.5%)	Yes
Alcohol	Yes	Battery acid	Yes
Crude oil	Yes	Nitric acid (10%)	Yes
Fatty acid	Yes	Caustic soda (diluted)	No
Glycerine	Yes	Caustic potash solution (diluted)	No
Heating oil	Yes	Seawater	Yes
Turpentine oil	Yes	Potassium chloride (diluted)	Yes
Carbon tetrachloride	No	Sodium hypochlorite (diluted)	Yes

RECYCLING OF SMC/BMC:

TODAY AND IN THE FUTURE.



A number of SMC producers and raw material suppliers in Europe founded ERCOM in 1991 to prove that these composite materials can be mechanically recycled at the highest level and reused for essentially the same applications. The automotive and electrotechnical industry – main customers of the SMC industry – demanded absolute proof of the recyclability on a production scale.

THE ESSENTIAL STEPS IN SETTING UP THE SYSTEM WERE AS FOLLOWS:

- Start-up of a mobile shredder and a processing plant using production scrap in 1992,
- Development of a quality system for recycle production and SMC parts,
- Tests and approval of primary parts with recycle,
- Setting-up dismantling plants and collection systems with other industrial partners for postconsumer parts from the automotive and electrotechnical industry starting in 1993/94,
- Development and implementation of criteria for dismantling to assure recycle quality.

SMC – THE MATERIAL IN THE FOREFRONT OF CONSERVATION OF RESOURCES:

The European composite industry recognized at an early stage the importance of setting-up recycling systems before any governmental regulations were enforced. ERCOM is operating in Germany and VALCOR in France.

In Germany the so called Loop Recycling and Waste Act became Law in October 1996, two years after it was passed by the legislature. It spells out the producer's responsibility from „cradle to grave“ for all products, including post-industrial waste. Priorities are set for the recovery and disposal of waste with mechanical recycling and primary use practiced in the particle recycling process for SMC at the highest priority (see chart).

Loop Recycling Act

PRIORITIES FOR RECOVERY AND DISPOSAL OF WASTE

REUSE
MECHANICAL RECYCLING
FEEDSTOCK RECYCLING
ENERGY FROM WASTE

COMBUSTION FOR DISPOSAL
LANDFILL OF DISPOSAL

SMC INDUSTRY MEETS THE CHALLENGE

The SMC industry had already anticipated this kind of legislation and set up recycling systems.

One such system is **ERCOM**, Germany established 1990 initially to deal with production waste but ultimately also to deal with post consumer waste. The following flow diagrams give an overview of the ERCOM system.



PROPERTIES OF ELECTRICAL APPLICATIONS

Within the electrical industry the main segments are:

- cabinets
- lamphousing
- switches

You will learn more about the specific properties of SMC/BMC on the following pages.

PROPERTIES FOR SMC ELECTRICAL INDUSTRY

CABINETS

METHOD (SHORT NAME)	STANDARD	UNIT	STANDARD	HIGH PERFORMANCE
1. Mechanical properties				
1.1 Tensile strength	DIN EN ISO 527-4	MPa	60	80
1.2 Tensile modulus	DIN EN ISO 527-4	MPa	8.500	11.000
1.3 Elongation	DIN EN ISO 527-4	%	1,5	1,8
1.4 Flexural strength	DIN EN ISO 14125 A	MPa	140	165
1.5 Flexural modulus	DIN EN ISO 14125 A	MPa	8.000	11.000
1.6 Fibre stress	DIN EN ISO 14125 A	%	2,2	2,5
1.7 Compressive strength	ISO 14 126	MPa	150	180
1.8 Compressive modulus	DIN EN ISO 604	MPa	8.000	11.000
1.9 Charpy impact strength	DIN EN ISO 179-1	kJ/m ²	50	80

METHOD (SHORT NAME)	STANDARD	UNIT	STANDARD	HIGH PERFORMANCE
2. Thermal properties				
2.1 Temperature of deflection under load (dimensional stability)	ISO 75-2A	°C	>200	>220
2.2 Coefficient of linear thermal expansion	ISO 11 359-2	10E-6/K	20	12
2.3 Temperature Index	IEC 60216-1	°C	150	160

3. Electrical properties				
3.1 Volume resistivity	IEC 60093	Ohm x cm	>10 ¹³	>10 ¹³
3.2 Surface resistance	IEC 60093	Ohm	>10 ¹³	>10 ¹³
3.3 Di-electric strength	IEC 60243-1	kV/mm	15	25
3.4 Comp. tracking index	IEC 60112	CTI	600	600
3.5 Dielectric dissipation factor	IEC 60250		0,02	0,01

4. Flammability				
4.1 Oxygen index	ISO 4589	%	22	35
4.2 Tests for flammability	UL 94	Class	HB	V0
4.3 Flammability glow bar	IEC 60707-3 (VDE 0304-3)	Step	BH 2-95	BH 2-10
4.4 Fire hazard testing Glow-wire test	IEC 60965-2-1 (VDE 0471-2-1)	°C	850	960

5. Chemical and physical properties				
5.1 Specific gravity (density)	ISO 1183	g/cm ³	1,7–1,9	1,7–1,9
5.2 Moulding Shrinkage	ISO 2577	%	0,15	0,05
5.3 Water absorption	ISO 62	%	0,25	0,25

LAMPHOUSINGS

METHOD (SHORT NAME)	STANDARD	UNIT	STANDARD	HIGH PERFORMANCE
1. Mechanical properties				
1.1 Tensile strength	DIN EN ISO 527-4	MPa	45	70
1.2 Tensile modulus	DIN EN ISO 527-4	MPa	7.000	11.000
1.3 Elongation	DIN EN ISO 527-4	%	1,5	1,8
1.4 Flexural strength	DIN EN ISO 14125 A	MPa	120	160
1.5 Flexural modulus	DIN EN ISO 14125 A	MPa	7.000	11.000
1.6 Fibre stress	DIN EN ISO 14125 A	%	2,2	2,5
1.7 Compressive strength	ISO 14 126	MPa	120	160
1.8 Compressive modulus	DIN EN ISO 604	MPa	7.000	11.000
1.9 Charpy impact strength	DIN EN ISO 179-1	kJ/m ²	45	80

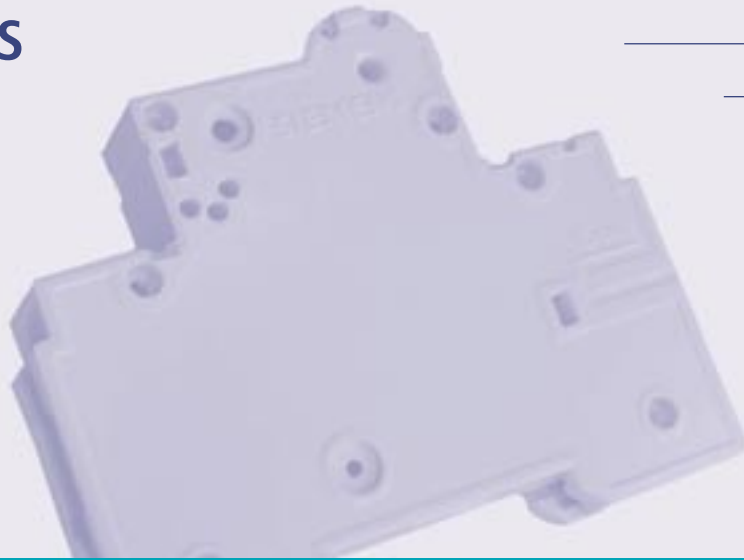
2. Thermal properties				
2.1 Temperature of deflection under load (dimensional stability)	ISO 75-2A	°C	>180	>220
2.2 Coefficient of linear thermal expansion	ISO 11 359-2	10E-6/K	20	12
2.3 Temperature Index	IEC 60216-1	°C	145	160

METHOD (SHORT NAME)	STANDARD	UNIT	STANDARD	HIGH PERFORMANCE
3. Electrical properties				
3.1 Volume resistivity	IEC 60093	Ohm x cm	>10 ¹³	>10 ¹³
3.2 Surface resistance	IEC 60093	Ohm	>10 ¹³	>10 ¹³
3.3 di-electric strength	IEC 60243-1	kV/mm	15	25
3.4 Comp. tracking index	IEC 60112	CTI	600	600
3.5 Dielectric dissipation factor	IEC 60250		0,02	0,01

4. Flammability				
4.1 Oxygen index	ISO 4589	%	22	35
4.2 Tests for flammability	UL 94	Class	HB	V0
4.3 Flammability glow bar	IEC 60707-3 (VDE 0304-3)	Step	BH 2-95	BH 2-10
4.4 Fire hazard testing Glow-wire test	IEC 60965-2-1 (VDE 0471-2-1)	°C	750	960

5. Chemical and physical properties				
5.1 Specific gravity (density)	ISO 1183	g/cm ³	1,7–1,9	1,7–1,9
5.2 Moulding Shrinkage	ISO 2577	%	0,15	0,05
5.3 Water absorption	ISO 62	%	0,25	0,25

SWITCHES



METHOD (SHORT NAME)	STANDARD	UNIT	BMC
1. Mechanical properties			
1.1 Tensile strength	DIN EN ISO 527-4	MPa	33
1.2 Tensile modulus	DIN EN ISO 527-4	MPa	12.000
1.3 Elongation	DIN EN ISO 527-4	%	0,3
1.4 Flexural strength	DIN EN ISO 14125 A	MPa	100
1.5 Flexural modulus	DIN EN ISO 14125 A	MPa	10.000
1.6 Fibre stress	DIN EN ISO 14125 A	%	1,2
1.7 Compressive strength	ISO 14 126	MPa	120
1.8 Compressive modulus	DIN EN ISO 604	MPa	12.000
1.9 Charpy impact strength	DIN EN ISO 179-1	kJ/m2	30

2. Thermal properties			
2.1 Temperature of deflection under load (dimensional stability)	ISO 75-2A	°C	>240
2.2 Coefficient of linear thermal expansion	ISO 11 359-2	10E-6/K	15
2.3 Temperature Index	IEC 60216-1	°C	160

METHOD (SHORT NAME)	STANDARD	UNIT	BMC
3. Electrical properties			
3.1 Volume resistivity	IEC 60093	Ohm x cm	$> 10^{13}$
3.2 Surface resistance	IEC 60093	Ohm	$> 10^{13}$
3.3 Di-electric strength	IEC 60243-1	kV/mm	20
3.4 Comp. tracking index	IEC 60112	CTI	600
3.5 Dielectric dissipation factor	IEC 60250		0,01

4. Flammability			
4.1 Oxygen index	ISO 4589	%	22
4.2 Tests for flammability	UL 94	Class	HB
4.3 Flammability glow bar	IEC 60707-3 (VDE 0304-3)	Step	BH 2-95
4.4 Fire hazard testing Glow-wire test	IEC 60965-2-1 (VDE 0471-2-1)	°C	850

5. Chemical and physical properties			
5.1 Specific gravity (density)	ISO 1183	g/cm ³	1,9-2,1
5.2 Moulding Shrinkage	ISO 2577	%	0,1
5.3 Water absorption	ISO 62	%	0,1

IMPRINT



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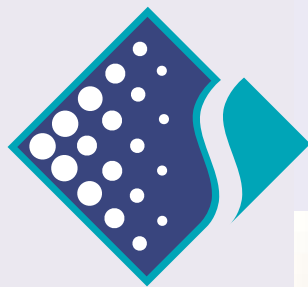
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DSM Composite Resins

