Powercam Electricals Private Limited (PEPL)

Technical Notes

Thermoplastics, Thermoset Composite Insulating Materials

& their Moulding Techniques

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Contents

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1. *Introduction:*

Plastic is a synthetic material made from polymers, which are large molecules composed of repeating subunits. These forms can be liquid or paste like resins for embedding, coating, and adhesive bonding, or they can be moulded, laminated, or formed shapes, including sheet, film, or larger-mass bulk shapes. It can be moulded into various shapes and forms, making it a versatile material widely used in electrical insulation, packaging, construction, and many other industries. Powermat uses two type of polymer, thermoplastic and thermoset plastics.

Thermoplastic: Plastics that can be deformed easily upon heating and can be bent easily. Linear polymers and a combination of linear and cross-linked polymers come under thermoplastics. Example: PVC, nylon, polythene, etc.

Thermosetting: Plastics that cannot be softened again by heating once they are moulded. Heavily cross-linked polymers come under the category of thermosetting plastics. Example: Bakelite, melamine, Sheet Moulding Compound & Dough Moulding Compound.

2. *Thermoset Composite Material & its Moulding Technique*

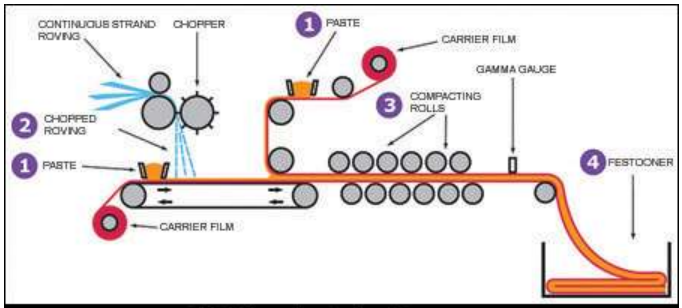
Composites are defined as “a combination of plastic resin and fibre reinforcement.” Another term for composites is used in the past is reinforced plastics.

2.1 *Sheet Moulding Compound:*

Sheet moulding compound (**SMC**) or **sheet moulding composite** is a ready to mould glass-fibre reinforced polyester material primarily used in compression moulding.[1] The sheet is provided in rolls weighing up to 100 kg. Alternatively, the resin and related materials may be mixed on site when a producer wants greater control over the chemistry and filler.

2.2 *Process:*

Sheet Moulding Compound (SMC) is a compression moulding compound often used for larger parts where higher mechanical strength is needed. SMC is a fibre reinforced thermoset material. Glass reinforcement is between 10% and 50%, and glass length is slightly longer than Dough Moulding Compound (DMC) - between 1/2-inch and 1-inch (25mm).



SMC Manufacturing Process

Thermoset Sheet Moulding Compound (SMC) is a mixture of polymer resin, inert fillers, fiber reinforcement, catalysts, pigments and stabilizers, release agents, and thickeners and possesses strong dielectric properties. Manufacture of sheet moulding compounds is a continuous in-line process. The material is sheathed both top and bottom with a polyethylene or nylon plastic film to prevent auto-adhesion. The paste is spread uniformly onto the bottom film. Chopped glass fibers are randomly deposited onto the paste. The top film is introduced and the sandwich is rolled into a pre-determined thickness. The sheet is allowed to mature for 48 hours.
Sheet moulding compounds can be moulded into complex shapes. Superior mechanical properties and surface appearance, plus excellent electrical insulation make this thermoset material ideal for automotive Class A body panels, high-strength electrical parts, business equipment cabinets, personal watercraft, and various structural components.

2.3 *Dough Moulding Compound:*

Dough Moulding Compound (DMC) is a thermoset plastic resin blend of various inert fillers, fiber reinforcement, catalysts, stabilizers, and pigments that form a viscous, 'puttylike' moulding compound. DMC is highly filled and reinforced with short fibers. Glass reinforcement represents between 10% and 30%, with glass length typically between 6mm to 12mm. Depending on the end-use application, dough moulding compounds are formulated to achieve close dimensional control, flame and track resistance, electrical insulation, corrosion and stain resistance, superior mechanical properties, low shrink, and colour stability. Its excellent flow characteristics, dielectric properties, and flame resistance make this thermoset material well-suited to a wide variety of applications requiring precision in detail and dimensions as well as high performance.

2.4 *Process*

Basic raw materials are resins, additives, catalysts, mould release agents and fillers. For coloured compounds, a pigment is added to the paste.The paste is then mixed with fibres, usually glass fibres. Bulk Moulding Compound (BMC) is prepared in a mixer. After preparing a base paste it will be loaded into the mixing device. Then all other ingredients are added and

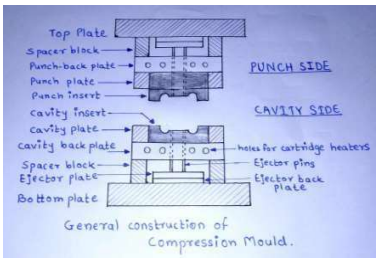
homogenized. The compound is packed into bags until moulding. To avoid any material changes during storage and transport it is packaged in a styrene tight packaging.

2.5 Process Used for Moulding SMC & DMC Composite Materials

Compression Moulding require following components:

2.5.1. Component raw materials SMC is available in Sheet form; DMC is available in dough form & Metal inserts if required.

2.5.2. Mould with desired shaped cavity

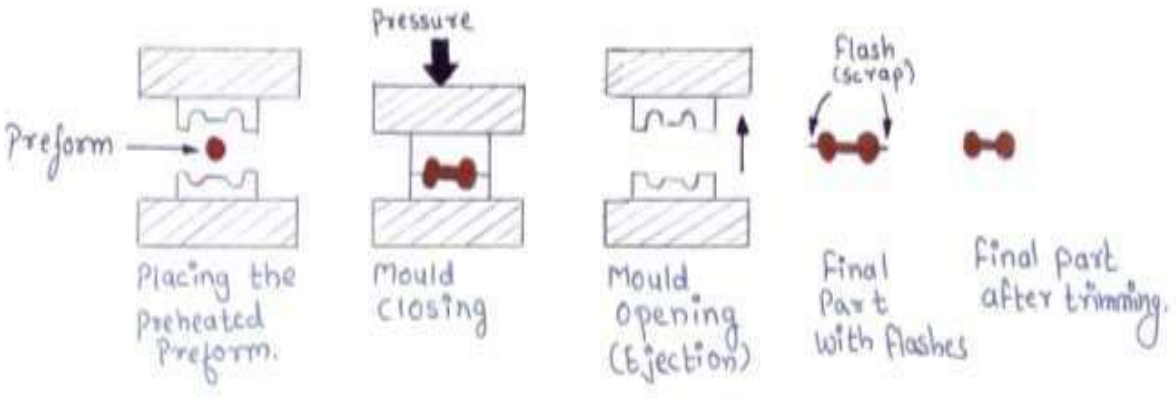


2.5.3. Moulding Machine The machine is the fundamental element of this process. A compression moulding machine is like a power press except power press have a

fast operation and do not stay for more time at stroke. CM machines stay for a predetermined time when actuated. It is more like a UTM machine. According to the shape and volume of the finished product, machine tonnage is decided. We have machines from 25 ton to 500 ton.

2.5.4. Process Flow:

a. Heating the Mould (temperature 165 deg C maximum)
b. Placing the material in the cavity & close the mould.
c. Curing Reaction depends on the shape & volume of the raw material.
d. Mould opening & Ejection.
e. Cleaning the Mould for next operation.
f. Post moulding operation for deflashing.



g. Quality check of molded products
h. Packing and dispatch

3. *Thermoplastic Material & its Moulding Technique*

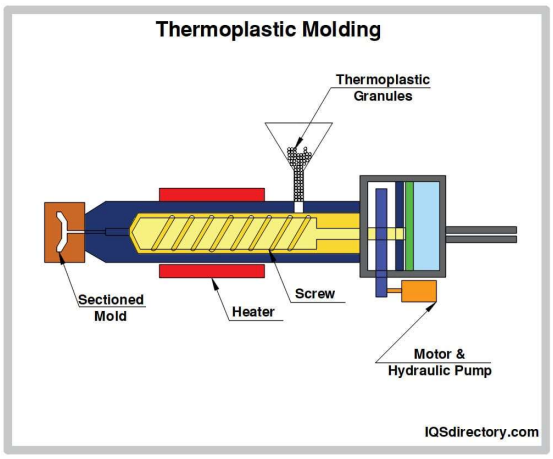
All the plastic materials which can be softened and melted by heating, but they set again when cool are called thermoplastics.

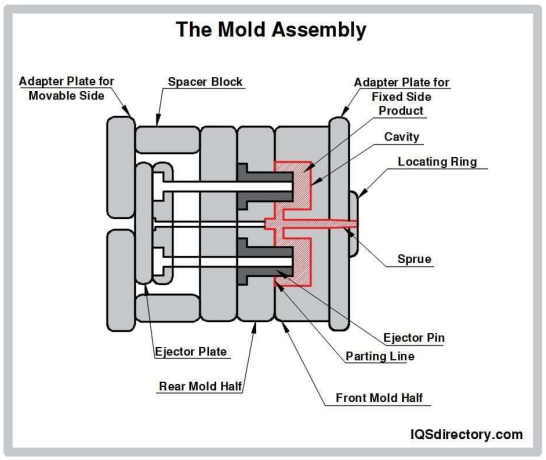
Many thermoplastic polymers are reinforced with fibres. Reinforcement is used to improve physical properties – specifically heat deflection temperature. Glass fibres are the most used reinforcing material. The wear resistance and abrasion resistance of thermoplastic polymers are improved using aramid reinforcing. Although fibres can be used with any thermoplastic polymer, the following are the most important.

- Polyamide polymers use glass fibres to control brittleness. Tensile strengths are increased by a factor of three, and heat deflection temperature increases from 150 to 500°F.
- Polycarbonate compounds using 10, 20, 30 and 40% glass fibre loading have their physical properties greatly improved.
- Other polymers benefiting from the addition of glass fibres include polyphenylene sulfide, polypropylene and polyethersulfone.
-

3.1 Process Used for Moulding Thermoplastic Materials

The thermoplastic injection moulding process starts with the addition of pellets to a hopper. Thereafter, the material is passed through a heated barrel where the rotation of the screw initiates a shearing action causing the pellets to melt. The material is pushed at high pressure such that the mold cavities are filled. Once the cooling cycle ends, the mold is opened to release the molded parts manufactured by thermoplastic injection moulding process.





3.2 Steps:

Injection moulding requires following component.

a. Clamping unit is described in terms of machine tonnage.
b. Mould for the desired shape
c. Injection Unit for injecting the molten material into the mould.
d. Dwelling and cooling unit allows the molten material to settle & holding pressure is used to replace injection pressure in this step to compact the molten plastic during its solidification.
e. Ejection Process, the cooled part is separated from the mould in this stage.
f. Trimming process , the last stage where the excess cooled plastic material is trimmed from the finished part.

4. *Difference between Thermoplastic Injection Moulding & Thermoset Mouldings*

Thermoplastic Injection Moulding vs. Thermoset Moulding

The way thermosets are made differs from thermoplastics in several aspects, and both the categories require varied treatment during the injection moulding process. Included below are a few differences when moulding thermosets and thermoplastics.

Thermosets	Thermoplastics
When producing parts, the cold material is injected into a hot mold	When producing parts, the plastic material is melted and injected into a mold
Can't be remolded or reshaped	Can be remolded and recycled
Forms a permanent chemical bond	100% reversible, as no chemical bonding takes place during the process
Comparatively difficult to surface finish	Thermoplastics result in accurate, flexible, and pleasing surface finishes
Does not require high heat and high pressure compared to thermoplastics moulding	Requires high heat and high pressure
Thermosets are made by condensation polymerization	Thermoplastics are made by additional polymerization
The production process includes compression, transfer, and casting	The production process includes injection moulding, extrusion, and blow moulding
Some of the end products that come from thermosetting injection moulding include: Handles of tools, billiard balls, insulation, computers parts, television parts, any electronic equipment, gardening equipment, tools, sprockets, and cooking utensils	Some of the end products that come from thermoplastic injection moulding include: Vacuum cleaners, toys, machine screws, gear wheels, kettles, packaging film, sacks, power tool casings, toasters, gas pipes, and fittings
Disadvantages of thermosets are: unable to be recycled, and they release emissions referred to as volatile organic compounds (VOCs)	Disadvantages of thermoplastics are: they are expensive, easily melt when heated, and are hard to prototype

5. *Testing on Moulded Parts*

Following testing is done on the moulded products on regular basis in accordance with the international & national standards & the criterion of acceptance is to achieve or exceed the defined values. **(See Appendix 1-6)**

1. Mechanical testing includes:

Figure 1 Universal Testing Machine

Figure 2 Torques Tester

Figure 3 Compressive Strength

   a. *Cantilever / Bending Testing*
   b. *Tensile / Pulling Testing*
   c. Torque Strength
   d. Shear Testing
   e. Compressive Strength

2. Electrical Testing includes Breakdown Voltage

Figure 1 CTI Tester

Figure 2 Impulse Tester

   a. Insulation Resistance
   b. Impulse withstands Voltage.
   c. Comparative Tracking Index

3. Flammability Testing Includes:

Figure 1 GWIT Test

Figure 2 Heat Deflection Tester

   a. Glow Wire Flammability Index
   b. Glow Wire Ignition Test
   c. Flammability Test as per UL 94
   d. Heat Deflection Temperature Test

6. ***Applications***

In view of their excellent features and benefits, these materials will continue to be used for many demanding applications.

- Electrical & Electronics (mechanical integrity and electrical insulation)
  Low voltage and medium voltage energy systems
- Mass Transportation (light weight and fire resistance)
  Train, tram interior and body parts Electrical components Track switch components Under the hood components for trucks.
- Automotive & Truck (low fuel emissions through weight reduction)
  Light weight body panels for vehicles Lighting systems, headlamp reflectors and LED lighting Structural parts, front ends, etc.
- Domestic Appliances (manufacturing in large volumes)
  Iron heat shields Coffee machine components Microwave ware White goods components, grips, and handles Pump housings as metal substitution Motor housings as metal substitution.
- Engineering (strength and durability)
  Functional parts in mechanical engineering as metal substitution Pump components for various media Sport equipment, golf caddy Safety products for leisure and public application

Summery and conclusion

Powercam electricals Pvt. Ltd. is a global producer and supplier of SMC and DMC, and their products, particularly in the fields of electrical insulations under the brand name POWERMAT. To ensure provide the highest quality of insulator to their customers, company continuously involve in the research and development of the products. Multi-level quality check has carried out from raw material to finish product.

APPENDIX-1

QSA INTERNATIONAL

Certificate OF REGISTRATION

Powercam Electricals Private Limited

Address: F-9, Shopping Centre-I, Mansarover Garden, New Delhi-110015
Manufacturing Site: 09, 11, 12, 63, 64, 65, 66 M.I.E, Part-A, Bahadurgarh, Haryana 124507, India

Has submitted Declaration of Conformity (Ref. No. U0116-01, Dated: 16/01/2021) according to

Council Low Voltage Directive 2006/95/EC
IEC-60947-5-1, IEC -60044-1:1996, EN 14598-3:5.

Organization has been assessed and found to be conforming to the requirements of the stated directive and standards submitted through Declaration of conformity

Hence manufacturer places the CE marking with his own responsibility as follows:

CE

For the Products of

Current Transformers, SMC & BMC based Bus bar supports and standoff Insulators, Pilot Lights, Push Buttons, Polyamide based Standoff Insulators and bus bar Supports, Air Vent and Document Holder under the brand name "Powermat"

(Further description of the products / devices covered by this certificate are given in the Annexure attached)

By QSA International, UK

Certification Issue Date: 17/01/2023 ~ Certification Expiry Date: 16/01/2024

Registration Number : QSA-1502392
Initial Certification Date: 20 Feb 2013
Re-Certification Date: 17/01/2021
Certification Expiry Date: 16/01/2024

Stratford Ray
Certification Manager

QSA INTERNATIONAL LIMITED
27, Old Gloucester Street,
London, WC1N3AX, ENGLAND

CGA
Centre for Global Accreditation
Accreditation No. AB-145001

Email: info@qsai.co.uk
Web:www.qsai.co.uk

APPENDIX-2

QSA INTERNATIONAL

Certificate OF REGISTRATION

Powercam Electricals Private Limited

Address: F-9, Shopping Centre-I, Mansarover Garden, New Delhi-110015
Manufacturing Site: 09, 11, 12, 63, 64, 65, 66 M.I.E, Part-A, Bahadurgarh, Haryana 124507, India

has submitted Declaration of Conformity (dated: 31-08-2022) according to

Council Low Voltage Directive 2006/95/EC
IEC-60947-5-1, IEC -60044-1:1996, EN 14598-3:5

Organization has been assessed and found to be conforming to the requirements of the stated directive and standards submitted through Declaration of conformity

Hence manufacturer places the UKCA marking with his own responsibility as follows:

UKCA

For the Products of

Current Transformers, Epoxy, SMC & BMC based Bus bar supports and standoff Insulators for low and medium voltage applications, Pilot Lights, Push Buttons, Polyamide based Standoff Insulators and bus bar Supports, Air Vent and Document Holder under the brand name "Powermat"

(Further description of the products / devices covered by this certificate are given in the Annexure attached)

By QSA International, UK

Registration Number :QSA-21123055
Initial Certification Date :13 Sep 2022
Certification Expiry Date : 12 Sep 2025

Stanford Ray

Certification Manager

QSA INTERNATIONAL LIMITED
27, Old Gloucester Street,
London, WC1N3AX, ENGLAND

CGA
Centre for Global Accreditation
Accreditation No. AB-145001

Email: info@qsai.co.uk
Web:www.qsai.co.uk

APPENDIX-3

HISTORICAL

Panelboard and Switchboard Accessories - Component

See General Information for Panelboard and Switchboard Accessories - Component

POWERCAM ELECTRICALS PVT LTD E314972
Plot No.:9,11,12,63,64,65,66,67
M.I.E.
Bahadurgarh, Haryana 124507 INDIA
Conical Type standoff Insulators, Cat. Nos, Model(s) C625

CY Type standoff Insulators Cat. Nos, Model(s) CY2225

Drum Type standoff Insulators, Cat. Nos., Model(s) D420, D425, D620, D625, D850

Full Hex standoff Insulators, Cat. Nos, Model(s) 14HH420, 20HH620, 25HH(1/4")40 M, 25HH625

Hexagonal standoff Insulators, Model(s) Cat. Nos. PH6(7)20-V0, PH415(M4)-V0, PH420(M4)-V0, PH525(M5)-V0, PH620(M6)-V0, PH625(M6)-V0, PH630(M6)-V0, PH635(M6)-V0, PH640(M6)-V0, PH645L(M6)-V0, PH650L(M6)-V0, PH830(M8)-V0, PH835(M8)-V0, PH840(M8)-V0, PH840S(M8)-V0, PH845(M8)-V0, PH845L(M8)-V0, PH850(M8)-V0, PH860(M8)-V0, PH1035(M10)-V0, PH1040(M10)-V0, PH1045(M10)-V0, PH1050(M10)-V0, PH1060(M10)-V0, PH1070(M10)-V0, PH1075(M10)-V0, PH1240(M12)-V0, PH1250(M12)-V0, PH1260(M12)-V0, PH1270(M12)-V0, PH1275(M12)-V0, PH1280(M12)-V0, PH12100(M12)-V0, PH1660(M16)-V0, PH1670(M16)-V0, PH1675(M16)-V0, PH1680(M16)-V0, PH16100(M16)-V

Hexagonal standoff Insulators, Cat. Nos, Model(s) ENH1050, ENH1660, H1670, H416, H420, H516, H520, H525, H620, H625, H640, H645, H650, H825, H850, H860, H865, MH625

PH Type standoff Insulators, Cat. Nos, Model(s) PH645, SPH625, SPH845L

Standoff insulators, conical, Model(s) C1040, C1050, C1060, C1070, C1250, C1260, C1270, C630, C830, C840

Standoff insulators, cylindrical, Model(s) CY2630, CY2660, CY2663, CY3030, CY3040, CY3050, CY3060, CY3660, CY4040, CY4050, CY5050, CY5060, CY6060

Standoff insulators, drum, Model(s) D1035, D1040, D1045, D1050, D1051E, D1060, D1065, D1070, D1075, D1076E, D1250, D1260, D1265, D1270, D1275, D630, D635, D830, D835, D840, D845, D851E

Standoff insulators, hexagonal, Model(s) 20HH630, 20HH635, 20HH640, 20HH645, 20HH650, 20HH655, 20HH660, 25HH630, 25HH635, 25HH640, 25HH645, 25HH650, 25HH655, 25HH660, 25HH830, 25HH835, 25HH840, 25HH845, 25HH850, 25HH855, 25HH860, 35HH1030, 35HH1035, 35HH1040, 35HH1045, 35HH1050, 35HH1055, 35HH1060, 35HH830, 35HH835, 35HH840, 35HH845, 35HH850, 35HH855, 35HH860, 45HH10100, 45HH1035, 45HH1040, 45HH1045, 45HH1050, 45HH1055, 45HH1060, 45HH1070, 45HH1080, 45HH1090, 45HH12100, 45HH1235, 45HH1240, 45HH1245, 45HH1250, 45HH1255, 45HH1260, 45HH1270, 45HH1280, 45HH1290, 55HH10100, 55HH1040, 55HH1045, 55HH1050, 55HH1055, 55HH1060, 55HH1070, 55HH1080, 55HH1090, 55HH12100, 55HH1250, 55HH1260, 55HH1270, 55HH1280, 55HH1290, H1035, H1040, H1045, H1050, H1060, H1065, H1070, H1075, H1076E, H1250, H1260, H1265, H1270, H1275, H1276E, H630, H635, H830, H835, H840, H845, MH1035, MH835

Standoff insulators, multiple inserts, "PD Series", Model(s) PD60RH40, PD60RH50, PD60RH60, PD60RH70, PD60RH80

Standoff insulators, round hex, Model(s) 30RH1030, 30RH1035, 30RH1040, 30RH840, 40RH1030, 40RH1035, 40RH1040, 40RH1045, 40RH1050, 40RH1055, 40RH1060, 40RH1065, 40RH1070, 40RH1240, 40RH1245, 40RH1250, 40RH1255, 40RH1260, 40RH1265, 40RH1270, 60RH1240, 60RH1250, 60RH1260, 60RH1270, 60RH1280, 60RH1650, 60RH1660, 60RH1670, 60RH1680

Straight Type standoff Insulators, Cat. Nos, Model(s) 25.4HH(1/4")25.4M, M8614580, MV4050, MV5035, MV5050, MV5560, MV60130, MV6040, MV606560, MV6075, MV6090, MV70210, MV75130, MV7535, MV7550, MV7590, MV80300, MV859060, MV9011082, MV90130, MV90150, MV95300, MV9580

Water Tank Type standoff Insulators, Cat. Nos, Model(s) WT 061926, WT 1035, WTD(3/8") 35 M, WTM-625

Marking: Company name or tradename "PE" , "POWERMAT" and model designation.

Last Updated on 2019-07-18

APPENDIX-4

UL Product iQ®

Plastics - Component

COMPANY

POWERCAM ELECTRICALS PVT LTD
Plot No.:9,11,12,63,64,65,66,67
M.I.E.
Bahadurgarh, Haryana 124507 India

E249670

Dsg	Color	Min Thk mm	Flame Class	HWI	HAI	Elec Str	RTI Mech Imp	RTI Mech Str	HVTR	D495	CTI
Epoxy (EP) furnished as finished parts											
EP GC 31 FR GRADE	WT	3.0-3.3	V-0	-	-	130	130	130	-	-	-
Unsaturated Polyester (UP), Sheet Molding Compound (SMC) "Powermat" furnished as sheets											
PS25	ALL	3.0-3.3	V-0	0	0	105	130	130	0	4	0
Unsaturated polyester(UP), Dough Molding Compound (DMC) "Powermat" furnished as finished parts											
PD20	RD, BK, BN, GY	3.0	V-0	0	0	105	130	130	0	4	0
	BL, WT, IV	3.0	V-0	0	0	105	130	130	-	-	-

Marking: Company name, material designation On container, wrapper Or finished part.

Last Updated on 2022-11-25

APPENDIX-5

POWERMAT
An ISO 9001:2015 Company

Doc. TDS/PD20/001
Issue:00, Rev.00
Dated:08/04/2023

Technical Data Sheet for Dough moulding compound (DMC)-PD20

Material Data Sheet -PD20				
SN	Properties		Test Methods	Values
1	Specific Gravity		D-792	1.9
2	Glass Contents (%)		N/A	20
3	Water Absorption(24hrs) %		D-570	0.15
4	Tensile Strength (Kgf/cm2)		D-638	400
5	Flexural Strength (Kgf/cm2)		D-790	900
6	Impact Strength Izod (J/m)		D-256	250
7	Compressive Strength (Kgf/cm2)		D-695	1500
8	Dielectric Strength (KV/mm)		D-149	10
9	Comparative Tracking Index (Volts)		BS-5901	>600
10	ARC Resistance (Secs.)		D-495	180
11	FLAMMABILITY INDEX		UL-94	V-0
12	Glow Wire Test(°C)		IEC-60695-2-11	960
13	Hot Wire Ignition Test (Secs.)		D-3874	>120
14	RTI , Str (°C) (Thickness-3mm)		UL-746B	130
15	RTI, Elect. (°C) (Thickness -3mm)		UL-746B	105
16	High Voltage Arc Tracking Rate(mm/min)		UL-746A	0 through 10
17	High Amp Arc Ignition (mean no. of arcs)		UL-746A	>120
18	Material Group		IEC-60112	1
19	Pollution Degree		IEC-60950	3
20	Insulation Class		as per NEMA	B
21	Working Temp (°C)		-	(-) 40°C to 130° C

Note: - The data and information are given only as a guide and are not binding, no guarantee of their authenticity can therefore be assumed in all situations. The company reserve the rights to modify the features without prior notice in view of continued improvement and development.

APPENDIX-6

POWERMAT
An ISO 9001:2015 Company

Doc. TDS/PS25/001
Issue:00, Rev.00
Technical Data Sheet for Sheet moulding compound (SMC)-PS25 Dated:08/04/2023

Material Data Sheet -PS25				
SN	Properties		Test Methods	Values
1	Specific Gravity		D-792	1.7
2	Glass Contents (%)		N/A	25
3	Water Absorption(24hrs) %		D-570	0.2
4	Tensile Strength (Kgf/cm2)		D-638	700
5	Flexural Strength (Kgf/cm2)		D-790	1550
6	Impact Strength Izod (J/m)		D-256	600
7	Compressive Strength (Kgf/cm2)		D-695	1800
8	Dielectric Strength (KV/mm)		D-149	12
9	Comparative Tracking Index (Volts)		BS-5901	>600
10	ARC Resistance (Secs.)		D-495	180
11	FLAMMABILITY INDEX		UL-94	V-0
12	Glow Wire Test(°C)		IEC-60695-2-11	960
13	Hot Wire Ignition Test (Secs.)		D-3874	>120
14	RTI, Str (°C) (Thickness-3mm)		UL-746B	130
15	RTI, Elect. (°C) (Thickness -3mm)		UL-746B	105
16	High Voltage Arc Tracking Rate(mm/min)		UL-746A	0 through 10
17	High Amp Arc Ignition (mean no. of arcs)		UL-746A	>120
18	Material Group		IEC-60112	1
19	Pollution Degree		IEC-60950	3
20	Insulation Class		as per NEMA	B
21	Working Temp (°C)		-	(-) 40°C to 130° C

Note: - The data and information are given only as a guide and are not binding, no guarantee of their authenticity can therefore be assumed in all situations. The company reserve the rights to modify the features without prior notice in view of continued improvement and development.

APPENDIX-7

Powermat Infrastructure

POWERMAT
An ISO 9001 : 2015 & 14001 : 2015 Company

POWERMAT GROUP OF COMPANIES

An Overview

UNIT-I

UNIT-II

Powercam Electricals Pvt. Ltd.

Corporate Office:
F-9, Shopping Centre-I, Kalkaji Garden,
New Delhi-110019 (India)
Tel.: +91-11-25462125, 25175575, 25116836
E-mail: powermat@powermatindia.com • Website : www.powermatindia.com

Works/UNIT-1
Plot No. 9, 11, 12, 63, 64, 65, 66, 67,
M.I.E., Bahadurgarh-124507, Haryana (India)
Tel.: +91-1276-268317, 268318, 268319