

Composites

We Enable Energy

As one of the oldest industrial companies in Switzerland, founded in 1803, we focus on products and systems for power generation, transmission and distribution, rotating machines and mechanical engineering. Von Roll is the global market leader for insulation products and the only company to offer the complete range of insulation products, composites, consulting, tests and services for the electrotechnical industry.

For more than 100 years, we have been making outstanding contributions to this market, developing a number of highly innovative products that have enabled both steady increases in power output and smaller and more compact machines.

Customers enjoy the following benefits:

- » One single source for all insulating materials
- » Thorough expertise from power generation and transmission to its efficient utilization
- » Proven compatibility for system components
- » Testing at Von Roll of both materials and systems
- » Consulting for applications and technologies
- » Training in insulation materials and systems

Focusing on composites, we are the recognized experts in processing various substrates and resins. With our specially developed composite laminate product range, customers enjoy additional benefits:

- » Compliance with all international standards
- » Extreme mechanical load-bearing capacity
- » Excellent dielectric properties
- » High thermal and corrosion resistance
- » Light weight
- » Environmentally friendly

Von Roll provides a comprehensive spectrum of semi-finished and machined composite laminated products for electrotechnical and industrial applications. Due to their outstanding properties, composite materials are increasingly being used to substitute other materials such as metals.

Typical applications include electrical insulation, paper machines, medical equipment, pumps, cardboard folding, pallets for PCB soldering, electrical testing and ballistic and thermal protection.



An Endless Variety of Composites

From mica, glass, synthetic fibers, natural reinforcement materials, polyester to high-temperature-resistant resin systems: many combinations are possible. The wide variety of attributes, combined with the experience and technology of our machining centers, allows us to offer you the perfect solution. We can supply machined parts from customers' drawings, ready-made to be incorporated into many types of applications.

Composite laminates are materials made up of reinforcement layers impregnated with appropriate resins and then cured under heat and pressure.

Various types of reinforcement materials are used, such as:

- » Cellulose paper, mica paper
- » Fabrics: cotton, glass, carbon, polyester, synthetic fiber fabrics (e.g. aramid, carbon)
- » Glass mats

The most commonly used types of resins are:

- » Polyester
- » Epoxy
- » Phenolic
- » Polyimide
- » Silicone
- » Melamine
- » Vinyl ester
- » Cyanate ester

The selection and adapted formulation of resins, and the way in which they are combined with the various reinforcement layers available, enable a wide range of industrial composites to be created, each with different mechanical, electrical and thermal properties.

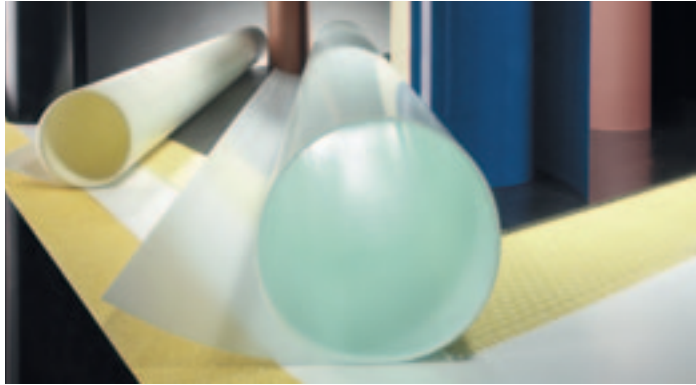
Composite materials are available in different forms:

- » Prepregs
- » Sheets and plates
- » Tubes and cylinders
- » Round and threaded rods
- » Machined parts

Prepregs

Von Roll manufactures and processes semi-finished products – sheets, tubes and molded parts – to the most exacting standards. Prepreg is the “pre-impregnated” material (B-stage) which is impregnated with resin but not yet cured.

Von Roll supplies prepregs for many applications (e.g. aviation industry, manufacturers of wind turbine generator equipment). Please consult us for further information.



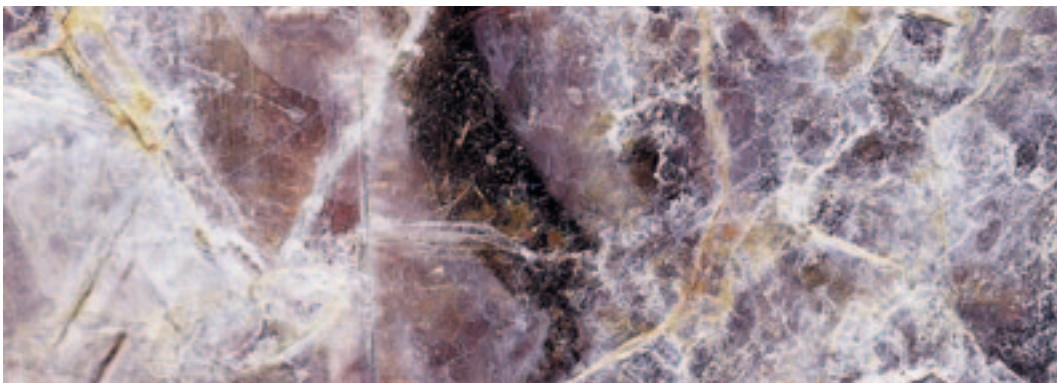
Prepregs

Mica Laminates

Mica is a mineral raw material with outstanding dielectric, thermal and physical properties. Von Roll developed the technique of converting high-grade sheet mica into mica paper under the registered trade name Samica® based either on muscovite or phlogopite. Samica® is then impregnated with an appropriate bonding resin and heat-pressed to be consolidated into Samicanite® laminates.

The various types of paper and the different resins and fillers enable Von Roll to achieve the particular properties of mica paper laminates, which are characterized by excellent electrical, mechanical and thermal properties.

Typical applications include electrical engineering, induction ovens, the automotive industry and the household appliances industry such as microwave ovens. Von Roll supplies various state-of-the-art products from mica paper sheets and tubes up to ready-to-use machined parts.



Mica

The following table provides a general overview and some highlights of our mica laminates:

Product name	Type	Matrix	Reinforcement	Standards	Heat resistance °C	Sheet size Thicknesses mm	Highlights	Main applications
Rigid								
Heater Samicanite®	41610	Silicone	Muscovite	IEC 60371-3-3 HP 5	600°C	1200 0/+2 x 1000 0/+2 0.2 to 2.0	Excellent thermal properties UL94 V-0 UL file E 332023	Heating resistance supports and insulation in household and industrial appliances
Heater Samicanite®	41620	Silicone	Phlogopite	IEC 60371-3-3 HP 5	600°C	1200 0/+2 x 1000 0/+2 0.2 to 2.0	Excellent thermal properties UL94 V-0 UL file E 332023	Heating resistance supports and insulation in household and industrial appliances
Pamitherm®	41140	Silicone	Muscovite	–	450 up to 800°C	1200 0/+2 x 1000 0/+2 2.0 to 60	Excellent fire resistance M0 F0 UL file E 332023	Thermal and mechanical parts insulating platens
Flexible								
Flexible Samicanite®	41220	Silicone	Muscovite	IEC 60371-3-3 HP 5J	180°C	1200 0/+2 x 1000 0/+2 0.2 to 2.0	Flexible, good electrical properties	Thermal and electrical shield in heating and industrial appliances
Miglasil® range	362.50	Silicone	Phlogopite	–	Up to 1200°C	Rolls of 25000 x 1000/0.27 and 0.40 sheets 570 x 1020 or 1500 x 1000 0.70/1.0/1.5/ 2.0 thick	Pure mica + silicone binder	Thermal and electrical shield in heating and industrial appliances
	368.90-10	Silicone	Phlogopite, glass	–	Up to 1200°C	Rolls of 25000 x 1000 thickness: 0.31	Pure mica + silicone binder + one layer of glass fabric	Thermal and electrical shield in heating and industrial appliances
	368.90-50	Silicone	Phlogopite, glass	–	Up to 1200°C	Rolls of 25000 x 1000 thickness: 0.62	Pure mica + silicone binder + two layers of glass fabric	Thermal and electrical shield in heating and industrial appliances

Glass Fabric Laminates

Glass fabric laminates are manufactured using high-pressure techniques and are characterized by extremely high mechanical strength and outstanding electrical and thermal properties. All Vetronite® laminates are made of glass fabric bonding with an appropriate resin system. In selecting a Vetronite® grade, various electrical, thermal and mechanical constraints have to be considered, as well as other properties such as expected life span, health and safety, and environmental factors.



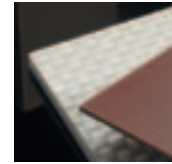
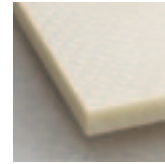
High-performance glass fabric laminates for electrical and mechanical engineering applications

Glass Fabric Laminates

The following table shows comparative values for different grades of Vetronite®:

Brand names	Units	Test methods	Vetronite® EGS 102	Vetronite® EGS 103	Vetronite® EGS 619
Composition					
Matrix			Epoxy	Epoxy	Epoxy
Reinforcement			Glass fabric	Glass fabric	Glass fabric
Standards	NEC 60893 NEMA LI-1 DIN 7735 (for info)		EP GC 201 G-10 HGW 2372	EP GC 203 G-11 HGW 2372.4	EP GC 202 FR-4 HGW 2372.1
Color			Green	Light beige	Light green
Form of delivery (mm)			2070 x 1070 1170 x 1070 0.2 to 150	2070 x 1070 1170 x 1070 0.2 to 100	2070 x 1070 1170 x 1070 0.2 to 150
Mechanical characteristics					
Flexural strength at 23°C flatwise	MPa	ISO 178	450	400	500
Flexural strength at 150°C flatwise	MPa	ISO 178	–	200	–
Flexural strength at 200°C flatwise	MPa	ISO 178	–	–	–
Edgewise notched impact strength Charpy	kJ/m²	ISO 179	55	55	70
Tensile strength // at 23°C	MPa	ISO 527	300	300	300
Compressive strength at 23°C flatwise	MPa	ISO 604	420	400	500
Electrical characteristics					
Insulation resistance (after immersion in water)	Ohm	IEC 60167	1E+12	1E+12	1E+12
Edgewise breakdown voltage (taper pin electrodes)	kV	IEC 60243-1	80	80	80
Flatwise breakdown voltage	kV/mm	IEC 60243-1	18	20	18
Comparative tracking index	V	IEC 60112	350	180	250
Physical characteristics					
Density	g/cm³	ISO 1183	1.85	1.85	1.92
Water absorption	%	ISO 62	0.05	0.06	0.05
Temperature index	°C	IEC 60216	130	155	130
Coefficient of linear expansion //	10-6/K	VDE 0304/VSM 77110	15	15	15
UL files			E47629		E47629
Highlights			Low temperatures and high humidity	Mechanical and electrical applications at high temperatures	High mechanical, electrical and electronics applications UL94V-0

Our products are compliant with RoHS directive 2002/95/EC.



	Vetronite® FR-5 HF CTI 600M	Vetronite® G-11	Vetronite® EGS T-23	Vetronite® G-11 Roving	Vetronite® PGS	Vetronite® SGS	Vetronite® Polyimide 64160
	Epoxy	Epoxy	Epoxy	Epoxy	Phenolic	Silicone	Polyimide
	Glass fabric	Glass fabric	Glass fabric	Glass roving	Glass fabric	Glass fabric	Glass fabric
	EP GC 204 FR-5 HGW 2372.2	EP GC 203/208 G-11 HGW 2372.4	EP GC 203/208 G-11 HGW 2372.4	EP GC 205 G-11 HGW 2370.4	PF GC 201 G-3 HGW 2072	SI GC 202 G-7 HGW 2572	PI GC 301 – –
	Red	Yellow brown	Yellow brown	Yellow brown	Brown	White	Brownish red
	2070 x 1070 0.2 to 100	2070 x 1070 1170 x 1070 0.2 to 150	2070 x 1070 1170 x 1070 0.2 to 150	2070 x 1070 1170 x 1070 2 to 150	2070 x 1070 1170 x 1070 0.2 to 20	2070 x 1070 1170 x 1070 0.2 to 50	1250 x 1250 0.35 to 38
	450	550	450	550	380	150	400 to 450
	300	350	350	410	–	–	–
	–	–	–	–	–	–	300
	60	75	60	200	40	50	70
	330	375	330	350	250	130	300
	550	620	500	330	450	450	450
	1E+11	1E+12	5E+12	1E+12	1E+9	1E+12	1E+12
	75	80	80	80	20	75	60
	15	20	18	20	6	8	10
	600M	500	200	500	200	600	200
	1.99	1.85	1.90	1.90	1.90	1.85	1.90
	0.05	0.04	0.05	0.05	0.20	0.10	0.25
	180	180	180	180	120	220	180
	15	15	15	15	15	12	15
	E47629						
	Low smoke emission and toxicity tracking resistant I1F1, UL94V-0	Excellent mechanical properties at high temperatures	High mechanical properties at high temperatures, highly chemical resistant	High tracking and excellent mechanical properties at high temperatures	Aeronautics approved ATS1000.001/ FAR25853, low smoke emission	High temperatures up to 220°C, UL 94V-0, high tracking resistance	High mechanical properties at high temperatures

Synthetic Fiber Laminates

Synthetic fiber laminates are made without glass and are manufactured using high-pressure techniques. They are characterized by extremely high mechanical strength, a low friction coefficient and excellent abrasion resistance.

Synthetic fiber laminates are used to make slides in high-performance rotary vacuum pumps and compressors, glide rods and friction discs – as well as operating rods in SF-6 circuit breakers, and wherever a high modulus of elasticity in tension is required.

Product name	Resin and reinforcement	Sheet size (mm)	Thickness range (mm)	Heat resistance	Applications	Highlights
ACG 600 T23	Epoxy and synthetic fabric	1150 x 1000 2050 x 1000	2.0 to 120	200°C	Slides	Good slide and wear resistance
AR 600 P 01	Phenol and aramid fabric	1150 x 1000 2050 x 1000	2.0 to 50	180°C	Slides	Good slide and wear resistance together with high mechanical resistance, low density
AR 600 T23	Epoxy and aramid fabric	1150 x 1000 2050 x 1000	2.0 to 50	200°C	Slides	Good slide and wear resistance together with high mechanical resistance, low coefficient of linear expansion, low density
Polyfibrite®	Epoxy and polyester fabric	1170 x 1070 2070 x 1070	2.0 to 50	150°C	Switch-gears	Resistant in SF-6 environment, good electrical properties, low density



Synthetic fiber laminates



Vacuum pump containing synthetic fiber laminate slides

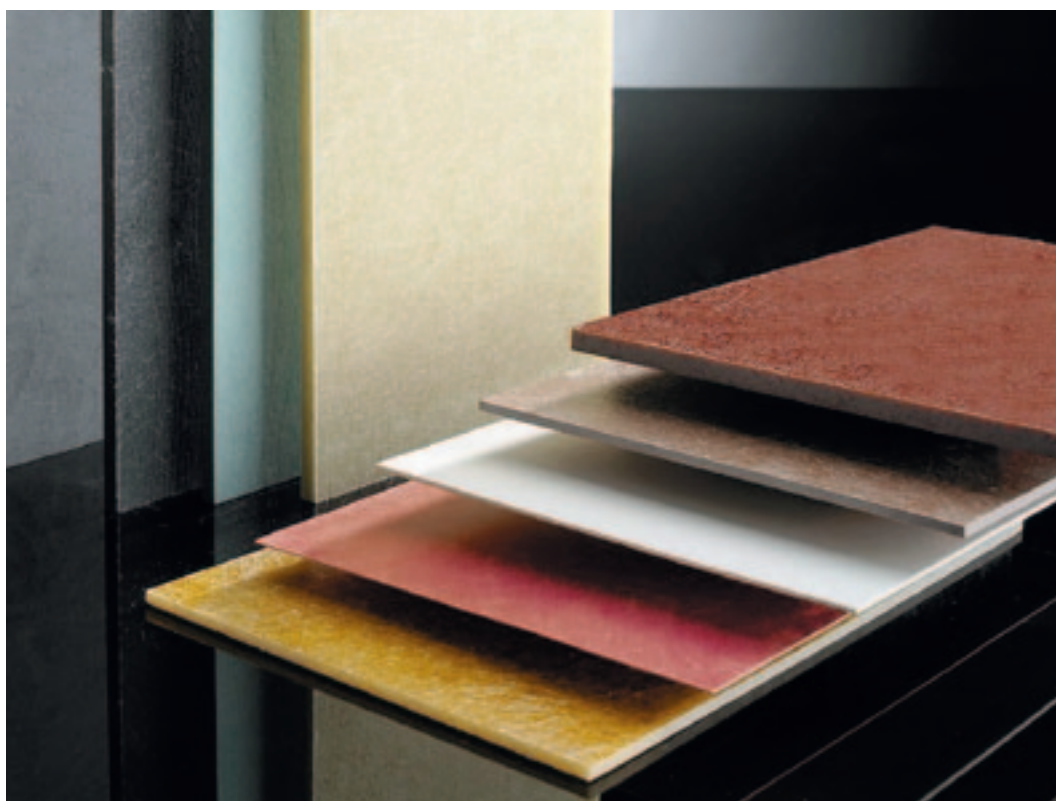
Glass Mat Laminates

Glass mat laminates are manufactured using low-pressure techniques and are characterized using mainly glass mat or chopped glass as a reinforcement material bonded with a polyester or epoxy resin system. Fillers and other chemical additives are also added to create the required combination of properties. All glass mat laminates may be identified under the two registered trademarks of Delmat® and Durapol®.

To select the appropriate grade of Delmat® and Durapol® laminate, various electrical and mechanical requirements have to be taken into account as well as expected life span and safety factors.

Delmat® and Durapol® laminates are widely used in the electro-mechanical industries. Von Roll has also developed special qualities for the electronics industry and for thermal protection applications. The products are attractive both for their good mechanical and electrical properties, and their resistance against corrosion at high-temperature levels.

More information is available in separate brochures called “Thermal protection” and “Electronics Industry”.



Glass mat laminates

Glass Mat Laminates

The following table shows comparative values for a selected list of Delmat® and Durapol® grades which have been tested in our laboratories and used successfully.

Brand names	Units	Test methods	Delmat® Polyester 68010 GPO-3	Delmat® Polyester 68020	Delmat® Polyester 68200	Durapol® F200 SMC
Composition						
Matrix			Polyester	Polyester	Polyester	Polyester
Reinforcement			Glass mat	Glass mat	Glass mat	Chopped glass fibers
Standards	NEC 60893 NEMA LI-1 DIN 7735 (for info)		UP GM 203 GPO-3 Hm 2471	UP GM 203 GPO-3 Hm 2471	UP GM 203 GPO-3 Hm 2471	UP GM 203 GPO-3 –
Color Similar to			Red RAL 3003	White RAL 9001	Gray RAL 7035	Red RAL 3018 Gray RAL 7035 White RAL 9001
Form of delivery (mm)			2000 x 1000 0.80 to 60	2000 x 1000 0.80 to 60	2000 x 1000 0.80 to 60	2000 x 1250 4 to 60
Mechanical characteristics						
Flexural strength at 23°C flatwise	MPa	ISO 178	160	130	130	130
Flexural strength at 130°C flatwise	MPa	ISO 178	95	70	70	70
Flexural strength at 155°C flatwise	MPa	ISO 178	–	–	–	–
Edgewise notched impact strength Charpy	J/cm ²	ISO 179 3C	4.7	4.7	4.7	4.7
Tensile strength // at 23°C	MPa	ISO 527	100	70	70	70
Compressive strength at 23°C flatwise	MPa	ISO 604	280	260	230	220
Electrical characteristics						
Insulation resistance (after immersion in water)	MOhm	IEC 60167	10 ³	10 ³	10 ³	10 ⁵
Edgewise breakdown voltage (taper pin electrodes)	kV	IEC 60243-1	80	60	60	80
Flatwise breakdown voltage	kV/mm	IEC 60243-1	12	12	12	10
Comparative tracking index	V	IEC 60112	600	600	600	600
Physical characteristics						
Density	g/cm ³	ISO 1183	1.8 +/- 0.1	1.8 +/- 0.1	1.8 +/- 0.1	1.8 +/- 0.1
Water absorption	%	ISO 62	0.3	0.4	0.4	0.1
Temperature index		IEC 60216	155	155	155	155
Coefficient of linear expansion	10-6 / K		20	20	20	20
UL files			E 70284	E70284		
Highlights			Halogen-free M1 94V-0	Halogen-free M1 94V-0	Halogen-free	Mechanical properties, 94V-0

Our products are compliant with RoHS directive 2002/95/EC.



	Delmat® Polyester 68030	Delmat® Polyester 68420	Delmat® Polyester 68160	Delmat® Polyester 68170	Durapol® M600 SMC	Delmat® Epoxy 68660	Delmat® Epoxy 68690	Delmat® Roving 68670
	Polyester	Polyester	Polyester	Polyester	Polyester	Epoxy	Epoxy	Epoxy
	Glass mat	Glass mat	Glass mat	Glass mat	Chopped glass fibers + roving	Glass mat	Glass mat	Glass mat + UD roving
	UP GM 204/205 GPO-2 Hm 2472	UP GM 202 GPO-2 Hm 2471/2	UP GM 201 – Hm 2471	UP GM 201 – Hm 2471	UP GM 205 – –	EP GM 305 – –	EP GM 204 – –	– – –
	Brown RAL 8011	Red RAL 4002	Beige RAL 1002	Beige RAL 1001	Green RAL 6019	Natural	Red	Natural
	2000 x 1000 0.80 to 60	2000 x 1000 0.80 to 60	2000 x 1000 0.80/1.60	2000 x 1000 0.80 to 60	2000 x 1250 4 to 60	See data sheet 3 to 102	See data sheet 3 to 53	See data sheet
	250	210	100	200	250	400	400	600
	150	–	–	–	–	–	–	–
	–	120	–	–	120	200	200	300
	6	5	–	5	12	9	7	40
	150	100	70	85	150	250	250	500
	400	160	100	250	400	500	450	350
	10 ⁴	10 ⁴	5.10 ²	5.10 ²	10 ⁵	10 ⁵	10 ³	10 ⁴
	60	40	60	60	60	60	50	50
	9	11	14	12	12	13	13	9
	450	500	500	500	500	600	300	600
	1.8 +/- 0.1	1.8 +/- 0.1	1.6 +/- 0.1	1.7 +/- 0.1	1.9 +/- 0.1	1.9 +/- 0.1	1.9 +/- 0.1	1.9 +/- 0.1
	0.5	0.1	1	0.3	0.1	0.1	0.1	0.1
	155	155	200	210	155	180	180	180
	20	20	20	20	20	15	15	15
			E 70284	E 70284		E 70284		
	Mechanical properties, flame-retardant	Mechanical properties, flame-retardant	Flexible	Dimensional stability by high temperature	Dimensional stability, halogen-free 94V-0	Mechanical properties, solvent resis- tance	Mechanical properties, flame-retardant, halogen-free 94V-0	Mechanical properties, chemical resistance

Threaded Rods

Threaded rods and nuts known as Delglas® are machined from a special grade of epoxy glass laminate. They offer excellent resistance to humidity, seawater corrosion and chemical agents. Delglas® fastenings are well adapted for use in oil and in other dielectric liquids and operate at both very low and high temperatures (up to 180°C). In addition, they display high dielectric strength and very good tracking resistance. Rods are mainly used for the manufacture of cylinders and rollers.

Tensile strength of threads in Newton meter (Nm)	Nuts H = 1 D		Nuts H = 1.5 D		Nuts H = 2 D	
	23°C	155°C	23°C	155°C	23°C	155°C
Threaded rods with flats 68860						
M8	4800	2900	7300	4300	9800	5700
M10	8100	5000	12000	7500	15400	10400
M12	12900	7500	18500	11500	24800	14800
M16	24200	14300	33800	21300	42200	26500
M20	37800	23300	52800	32100	67900	40300
Threaded rods without flats 68860						
M8	6000	3000	9000	4500	10000	6600
M10	9000	5000	15000	8000	18000	11600
M12	14500	7500	22000	12000	28000	17000
M16	25000	15000	38000	21500	46500	29000
M20	40000	25000	57000	36000	75000	44500

Torque strength at rupture in Newton meter (Nm)	With flats		Without flats
	Unlocked	Locked	23°C
Threaded rods – non-lubricated, with Nuts H = 2 D			
M8	10	19	10
M10	16	37	20
M12	32	60	35
M16	82	110	85
M20	148	162	150



Cotton and Paper Laminates

Known under the trademark Canevasite®, the range of phenolic cotton laminates comprises several grades, each having specific properties and most of which are remarkable for their abrasion resistance and wear properties as well as good level of flexibility and very low level of water absorption.

Machined parts made from Canevasite® substantially extend the life of machines and mechanically stressed components, thereby resulting in excellent cost savings.

The Dellite® range encompasses a group of cellulose paper-based laminates that are either phenolic- or epoxy-bonded. All of these laminates comply with precise standards and/or specific requirements such as flame retardancy or high-tension resistance. Besides the well-known standard grades, we offer several special grades.

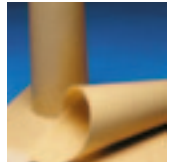


Cotton and paper laminates

Cotton and Paper Laminates

Brand names	Units	Test methods	Canevasite® F18 C6
Composition			
Matrix			Phenolic
Reinforcement			Cotton fabric
Standards	NEC 60893 NEMA LI-1 DIN 7735 (for info)		PF CC 201 similar – HGW 2082
Color			Black
Form of delivery (mm)			2000 x 1000 1000 x 1000 0.3 to 100
Mechanical characteristics			
Flexural strength at 23°C flatwise	MPa	ISO 178	133
Edgewise notched impact strength Charpy	kJ/m ²	ISO 179	14
Tensile strength // at 23°C	MPa	ISO 527	82
Compressive strength at 23°C flatwise	MPa	ISO 604	270
Electrical characteristics			
Insulation resistance (after immersion in water)	Ohm	IEC 60167	–
Edgewise breakdown voltage (taper pin electrodes)	kV	IEC 60243-1	–
Flatwise breakdown voltage	kV/mm	IEC 60243-1	–
Comparative tracking index	V	IEC 60112	–
Physical characteristics			
Density	g/cm ³	ISO 1183	1.37
Water absorption	%	ISO 62	0.73
Temperature index (TI)	°C	IEC 60216	120
Coefficient of linear expansion	10 ⁻⁶ /K	VDE 0304/VSM 77110	18
Highlights			Low friction coefficient 0.17

Our products are compliant with RoHS directive 2002/95/EC.



	Canevasite® FF-5964	Canevasite® FF-PTFE	Canevasite® VRI BAT	Canevasite® F18 V0 HF	Dellite® POT IV - N1	Dellite® 2063 V0
	Phenolic	Phenolic + Teflon	Phenolic	Epoxy	Phenolic	Phenolic
	Cotton fabric	Cotton fabric	Cotton batiste fabric	Cotton fabric	Paper	Paper
	PF CC 204 LE HGW 2083.5	PF CC 203 – HGW 2083 similar	PF CC 305 – –	– – –	PF CP 206 similar XXXPC similar HP 2062.8 similar	PF CP 205 FR-2 HP 2062.9
	Brown	Light beige	Brown	Red	Yellow brown	Light brown
	1150 x 1050 0.2 to 10	1150 x 1050 0.2 to 10	1000 x 1000 0.2 to 100	2000 x 1000 2.0 to 50	1170 x 1070 0.3 to 10	1070 x 1070 0.3 to 10
	130	135	135	110	180	120
	–	–	–	10	–	4
	85	80	85	70	100	70
	300	250	340	250	–	–
	1E+11	–	–	1E+8	1E+8	1E+11
	12	–	15	10	50	35
	2	–	2.25	5	10	10
	150	–	–	600	250	200
	1.34	1.45	1.30	1.50	1.34	1.39
	1.40	1.25	0.60	1.00	2.00	0.65
	120	120	120	150	120	105
	18	18	–	25	20	20
	Good wear resistance for lamellas in air motors, friction coefficient 0.25	Self-lubricating features, for lamellas in air motors, friction coefficient 0.15	Excellent mechanical properties, suitable for fine machining, friction coefficient 0.20	Mechanical and electrical applications UL94V-0	Special grade for potentiometer	Flame-retardant, cold punchable, UL94V-0 listed

Specialties

Von Roll offers a variety of composites based on various reinforcement materials – aramid, carbon, cotton and glass fabric – and resin systems that are manufactured in a special process and can be delivered to many industrial segments.

U and L Profiles

U and L profiles are high-performance machined components for use in rotors of large generators, in stators of large traction motors and windmills.

Different compositions are possible:

- » Vetronite® 64170, insulating: woven glass epoxy, temperature index 180°C
- » Vetronite® 432.10-01, conductive: woven glass epoxy, temperature index 155°C
- » Vetronite® 69090 inclusive Nomex®¹⁾: woven glass epoxy and Nomex®¹⁾, temperature index 155°C up to 180°C
- » Shaped Nomex®¹⁾: temperature index 210°C
- » Polyfibre: polyester cloth with epoxy resin, temperature index 150°C

Shapes depend on customer's design and assembly technology.

	Test methods	Test conditions	Units	Vetronite® 64170	Vetronite® 69090	Vetronite® 432.10-01
Mechanical characteristics						Thick. 0.8 mm
Tensile strength //	ISO 527	R;M/23°C/50%	MPa	400	300	–
Flatwise flexural strength at 23°C	ISO 178	R;M/23°C/50%	MPa	500	Above 300	Above 550
Flatwise flexural strength at 155°C	ISO 178	R;M/155°C ≤ 20%	MPa	300	Above 200	Above 275
Flatwise compressive strength at 23°C	ISO 604	R;M/23°C/50%	MPa	400	350	–
Flatwise shearing strength	IEC 60893-2	R;M/23°C/50%	MPa	150	150	–
Electrical characteristics						
Flatwise electric strength (direct test)	IEC 60243-1	1h/105°C ≤ 20% M/23°C/oil	kV/mm	25	28	–
Proof tracking index	IEC 60112	1h/105°C ≤ 20% M/23°C/50%	V	400	400	–
Volume resistivity	IEC 93	1h/105°C ≤ 20% M/23°C/50%	kOhm.cm ² /cm	1E11	1E11	2 to 20
Surface resistivity	IEC 93	1h/105°C ≤ 20% M/23°C/50%	kOhm.cm ² /cm	1E9	1E9	1 to 50
Electrical characteristics						
Density	ISO 1183	R;M/23°C/50%	g/cm ³	1.9 +/- 0.1	1.7 +/- 0.1	1.9 +/- 0.1

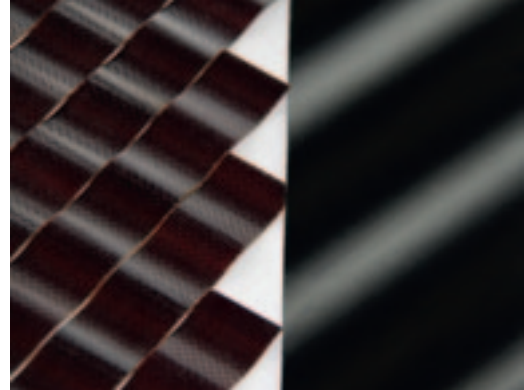
¹⁾ Nomex is a registered trade mark of Dupont®

Ripple springs for large generators

Von Roll offers top and side wedges to compensate the dimensional variations of slot wedges in stators. The Von Roll product offering covers traditional wedging based on flat materials as well as on spring-shaped slot-filling materials. The spring effect is designed to absorb the evolution of the remaining pressure inside the slot in order to eliminate vibrations and to guarantee a longer service life.



Ripple springs



Top and side ripple springs

Doctor blades for the paper industry

Doctor blades are thin composite coils designed for use in paper-making equipment. Blades are used on cylinders in order to remove continuously accumulating organic and inorganic residues. These contaminants can build up excessively, leading to defects when they are released onto the paper.

Based on different reinforcement materials (glass, aramid, carbon and cotton) with specific fillers (abrasive, graphite) and resin systems, doctor blades manufactured by Von Roll provide the solution to various problems relating to corrosion resistance, temperature resistance, wear and softness for paper machine cylinders.

Doctor blade products are manufactured in rolls up to 150 meters in length, and in various thicknesses up to 3.25 millimeters. Coils can be chamfered or routed.



Carbon doctor blades in roll strips



Doctor blades are used in the paper industry

Tubes and Cylinders

Von Roll is able to supply an extensive range of top-quality tubes and cylinders made from various reinforcement materials, such as Samica®, glass fabric, glass mat, cotton, paper, aramid, polypropylene and HiPer-tex. Materials are bonded with resin systems such as phenolic, silicone, polyester and epoxy. Depending on the grades, they can be supplied varnished or unvarnished in a very wide range of diameters and lengths, in standard sizes or made specially to customer specifications.

Product denomination	NEMA LI 1	IEC 61 212-3-1	Resin	Reinforce-ment	Inner diameter D min (mm)	Outer diameter D max (mm)	Length D max (mm)
Dellite® PF CP 21 T	X	PF CP 21	Phenolic	Paper	3.5	1400	2300
Dellite® PF CP 23 T	XX	PF CP 23	Phenolic	Paper	3.5	1400	2300
Canevasite® F24 5964 T	LE	PF CC 21	Phenolic	Cotton	5	1400	1500
Canevasite® FF 5964 T	LE	PF CC 21	Phenolic	Cotton	5	1400	2200
Canevasite® PF CC 22 T	C	PF CC 22	Phenolic	Cotton	7	1400	2200
Canevasite® VRI-BAT T	–	–	Phenolic	Cotton	2.6	1400	1000
Duratex T	–	–	Phenolic	Cotton	7	1400	2200
Duratex®-D T	–	–	Epoxy+ PTFE	Cotton	2.6	1400	1000
Vetronite® EGS 102 T	G-10	EP GC 21	Epoxy	Glass fabric	3.5	1400	1200
Vetronite® EGS T 23 T	G-11	EP GC 22	Epoxy	Glass fabric	8	1400	1000
Vetronite® FR-5 T	FR-5	–	Epoxy	Glass fabric	5	1400	1000
Vetronite® G-11 T	G-11	EP GC 22	Epoxy	Glass fabric	3.5	1400	1500
Vetronite® SGS T	G-7	SI GC 21	Silicone	Glass fabric	5	1400	1200
Samicanite®-S T	–	SI MP 21	Silicone	Mica paper	8	1400	950
Samicatherm® T	–	–	Epoxy	Mica paper	7	1400	950



Tubes and cylinders

Tubes and cylinders are used in various fields of application depending on their specific characteristics and properties. They can be found in circuit breakers, capacitors, dry-type transformers, cylinders for oil-type transformers, resistor banks and rotating machines, as well as in medical appliances and in ballistic protection. Tubes are used in large quantities for the manufacture of cage-bearing equipment, hydraulic and pneumatic apparatus, and various other engineering equipments and as coils/bobbins for paper, textile and foil production.

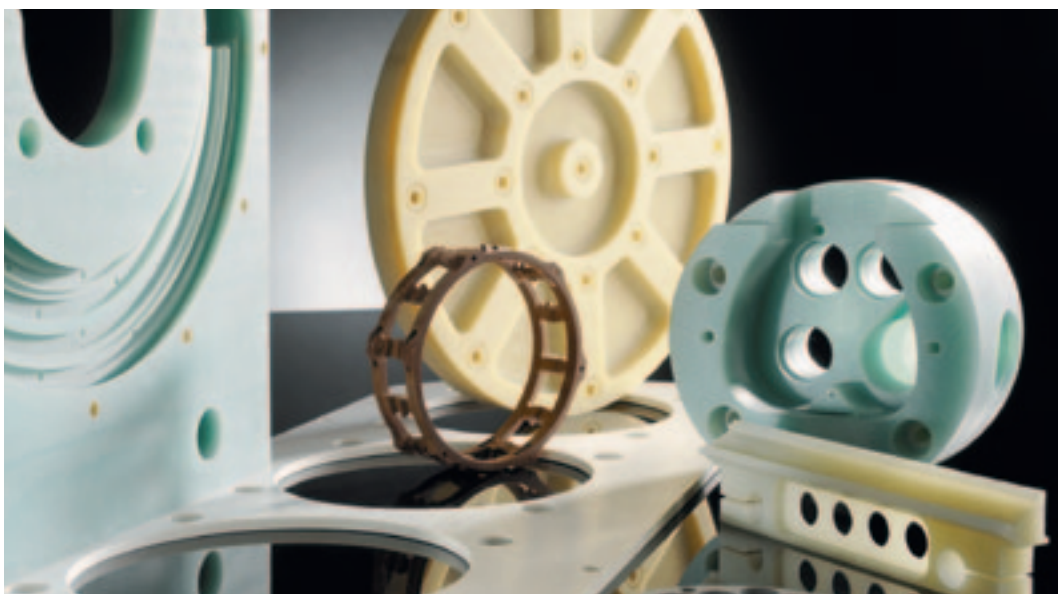
Machined Parts

Machining reinforced plastics, such as our high- and low-pressure laminates as well as our tubes, require the appropriate know-how, machines, tools and equipment. In our processing centers we can saw, as well as perform CNC (Computer Numerical Controlled) milling, turning, drilling and grinding in order to manufacture three-dimensional parts according to drawings. Our large range of modern equipment allows us to meet any customer requirements (up to five-axis milling operations).

In all cases, availability and service are key words in the machining of parts. Von Roll's organization makes it possible to offer customers the most efficient and economical service in terms of delivery dates, batch sizes, machining types and tolerance requirements: anytime, anywhere. Finally, combined multi-domestic experience in machining enables Von Roll to provide machining expertise and to adapt data-processing software. Finished parts are made with high precision using customers' drawings on CNC-controlled machining centers. With regards to tolerances and surface roughness, Von Roll is able to produce pieces in accordance with major international standards requirements.

We supply surface treatment and assembly services for our customers.

Von Roll produces also custom-made molded parts from various resin types – phenolic, melamine, epoxy and polyester – and reinforcing materials such as wood dust, cellulose, cotton fabric and glass fibers. More information is available in a separate brochure.



Machined parts

We Enable Energy

Von Roll is the sole full range supplier of materials and systems for the insulation of electrical machines as well as high-performance products for various high-tech industries.



Mica

All materials related to high-voltage insulation. Von Roll's commitment to mica starts with mining and ends with finished tapes.



Wires

Insulated round, flat and Litz wires for high-voltage, low-voltage and electronic applications.



Cables

Mica tapes for fire-resistant cables. Von Roll provides a wide range of products that are ideally suited to all commonly used standards.



Liquids

Impregnation resins for high and low voltage, potting resins, casting resins, as well as encapsulating and conformal coatings.



Composites

Engineered materials made from a resin and a support structure with distinct physical, thermal and electrical properties. They can be molded, machined or semi-finished.



Flexibles

Insulating flexible materials for low-voltage applications such as flexible laminates and adhesive tapes.



Ballistic Protection

High-quality systems for armored defense based on thermoset / thermoplastic products in single-use or tailored combinations.



Transformers

High-performance transformers for power transmission and distribution, tailored solutions to all applications of today's energy-supply companies.



Testing

Von Roll provides electrical, thermal and mechanical testing of individual materials as well as complete insulating systems. We are UL-certified.



Training

Von Roll Corporate University provides a training program in high- and low-voltage insulation to its customers.

Please contact us or visit our website www.vonroll.com for further information

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About Von Roll

We Enable Energy – As one of Switzerland's longest established industrial companies, Von Roll focuses on products and systems for power generation, transmission and distribution. Von Roll's business portfolio is divided into five business segments: **Von Roll Insulation** is the global market leader in insulation products, systems and services. **Von Roll Composites** produces composite materials and parts for assorted industry appliances. **Von Roll Transformers** offers complete solutions for the fast expanding market of high performance transformers. **Von Roll Water** provides solutions for process engineering tasks in the field of water and waste water management. **Von Roll Solar** is developing a third-generation solar cell.