Carbon Brush

(1) Carbon brushes for general industrial application
(2) Carbon brushes for power supply application
(3) Carbon brushes for automotive application
(4) Carbon brushes for home appliances
(5) Carbon brushes for micro motor
(6) Carbon brushes for electric power tool
(7) Carbon brushes for vacuum cleaner
(8) Carbon brushes with cut-off device

Features of Carbon Brush Products

The carbon brush plays the important role of sending electrical current between motionless and rotating parts by sliding contact. Since the performance of the brush has a significant impact of the performance of rotating machine, the choice of brush is a critical factor. At the Toyo Tanso Group, we develop and produce carbon brushes for a variety of customer needs and purposes, applying the superior technology and quality assurance know-how that we have developed over our many years of research in the field. Our products exude minimum impact on the environment, and can be used for many different applications.

Excellent self-lubrication and abrasion resistance

Carbon has self-lubricating properties and low coefficient of friction due to its layered crystal structure, making it highly abrasion resistant. The carbon is thus characterized by outstanding abrasion resistance and low friction under conduction, which is important for carbon brush.

Superior conductivity

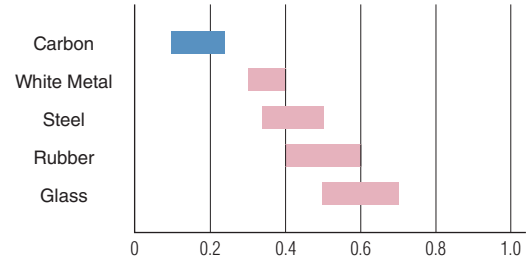
With its excellent electrical conductivity, carbon can offer a stable, optimal level of electrical resistivity, which is enhanced by appropriate selection of materials and production process depending on the application.

Outstanding durability

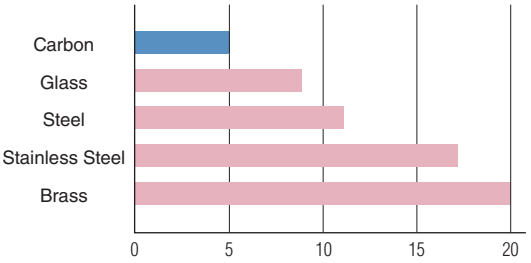
Carbon has low coefficient of thermal expansion, which means that it hardly has changes in shape or quality even at high temperatures. It is also resistant to the softening and melt-down that can occur due to sparking during operations, and does not fuse with other metals.

Superior ridability during sliding contact

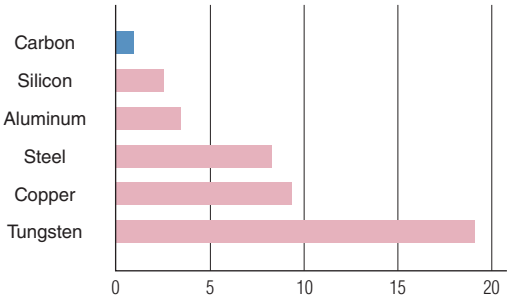
Compared to conductive metal in general, bulk density and the Young's modulus are small in carbon, hence carbon has superior ridability during sliding contact.



Coefficient of dynamic friction with steel surface [in air room temperature]

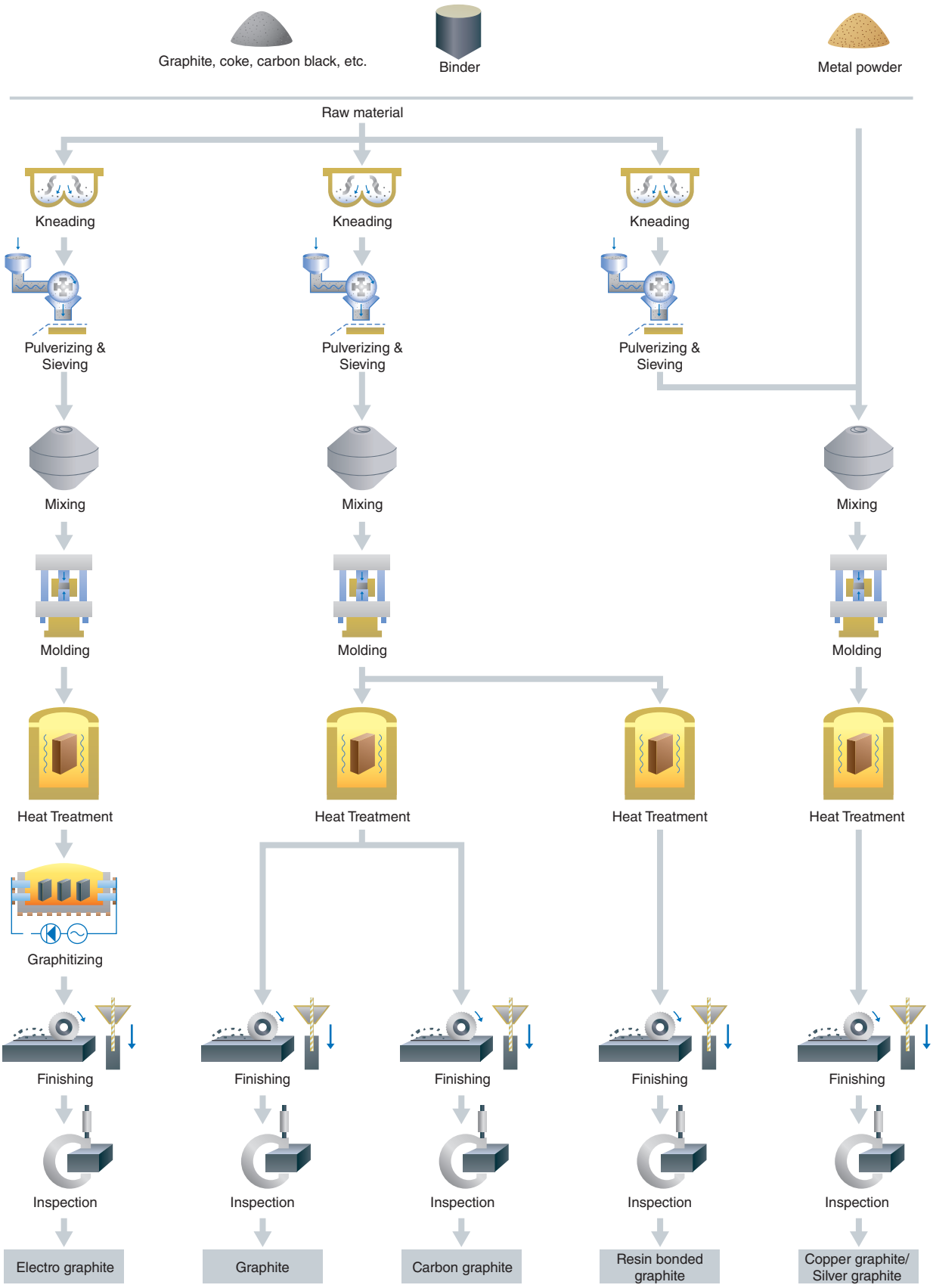


Coefficient of thermal expansion [10^{-6}/K]



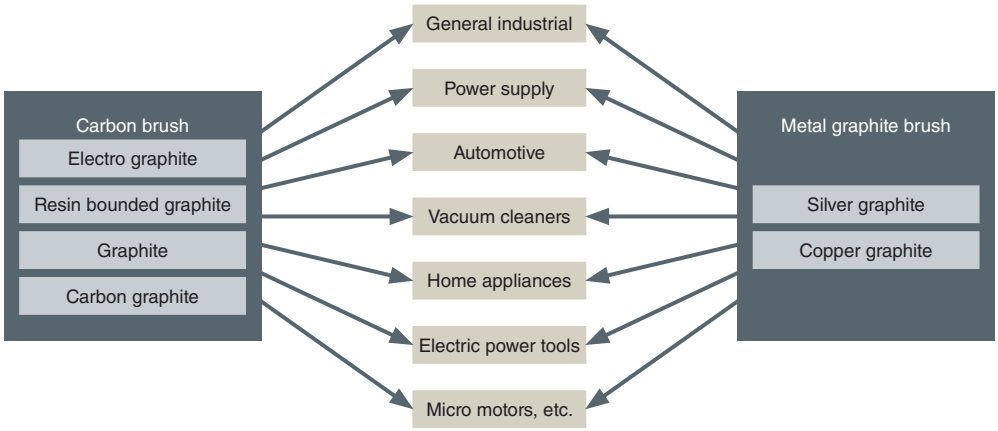
Bulk Density [g/cm^3]

Manufacturing Process



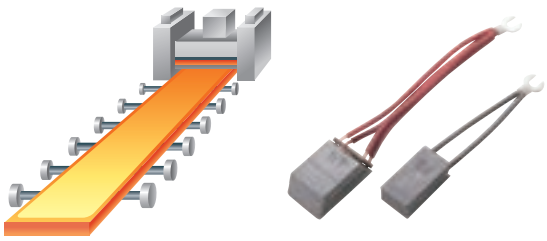
Brush Types and Applications: Some Examples

At Toyo Tanso group, we offer an entire array of brushes, including for general industrial use, vacuum cleaners, automotive, home electronic appliances, power tool motors, electrical supply, micro motors, and more.

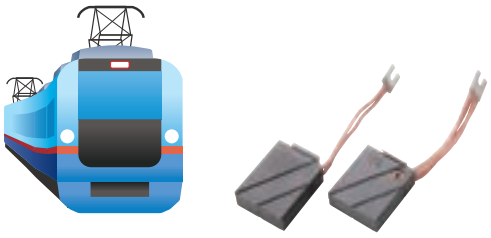


■ General industrial

DC motors



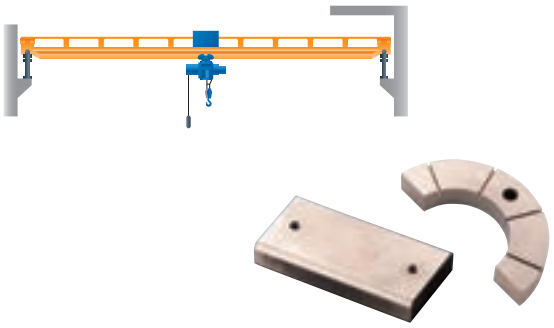
Electrical trains



Wind-generated power

■ Power supply

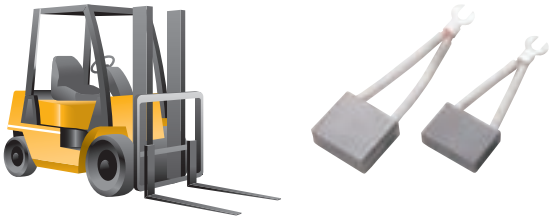
Cranes



■ Automotive application

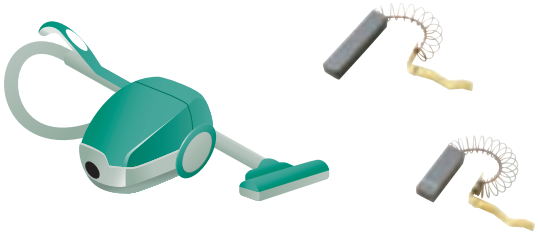
Automobiles

Forklifts



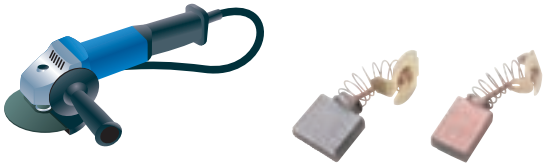
■ Vacuum cleaners

Vacuum cleaners



■ Power tools

Disk grinders

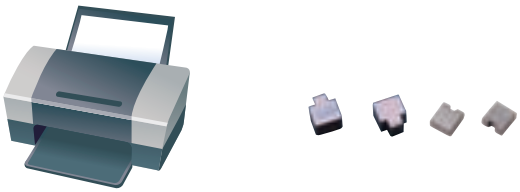


■ Home appliances

Washing machines

■ Micro motors, etc.

Printers



Product Descriptions

The Toyo Tanso Group is constantly researching ways to achieve top performance with our brushes for each of their various purposes. We have successfully developed a range of new products up through the present time, including special coated brushes, carbon brush with cut-off device, vehicle fuel pump brushes and carbon discs, and more.

■ Brushes and Carbon Disks for Vehicle Fuel Pumps

Carbon is the answer to the many conditions required for the commutator for vehicle fuel pumps. Toyo Tanso has developed optimal brush materials and low-wear carbon disc for commutator. We can propose the ideal carbon brush material to match usage conditions.

■ Carbon brush with cut-off device

At the end of their lifespan, brushes tend to incur greater sparking from commutation, as the spring pressure deteriorates. The brush with cut-off device quickly cuts electric current when brush is worn out to reduce commutator loss. Toyo Tanso offers cut-off design depend on brush type and application.

■ The washing machine brush

Extremly long life brushes are required for commutator motor for drum-type washing machine. Toyo Tanso offers a long- lasting brush that performs well even during the machine's reverse cycle.

■ The Specially Coated Brush

This brush features a thin conductive metal film coating on the surface. The coating serves to cut loss associated with electrical resistance and rises in temperatures without sacrificing life time and commutation properties of the brush. These brushes are used in small high-speed vacuum cleaners, power tool motors, and more.

Typical Properties

Composition	Grade	Bulk Density	Hardness	Electrical Resistivity	Flexural Strength	Cofficient of friction	Contact voltage drop	Max. peripheral speed	Max. current density	Features/applications
		g/cm³	HSC	μΩ·m	MPa		V	m/s	A/cm²	
Electrographite	401	1.68	18	9	10	M	M	30	10	Good film formation. Suitable for slip rings that easily generate streaking.
	502	1.77	51	11	37	M	M	25	10	Good roughing resistance because of fine grain isotropic structure. Suitable for low speed, small capacity DC motors and slip rings.
	503	1.68	46	13	29	M	M	30	10	Same as 502, good roughing resistance because of fine grain isotropic structure. Suitable for small/med capacity motors of faster speed than 502.
	176	1.62	28	14	16	M	M	45	12	Good film formation. Good communication performance. Suitable for DC motors up to medium capacity.
	BZ-229	1.6	23	22	11	M	M	40	12	Moderate film adjusting function. Suitable for medium and higher capacity mill motors.
	BZ-256	1.61	28	19	14	M	M	40	12	Better film formation than BZ-229. Suitable for medium and higher capacity mill motors.
	213	1.61	32	23	16	M	M	40	12	Better film adjusting effect than 176. Suitable for DC motors up to medium capacity.
	321	1.74	62	34	31	M	M	35	10	Good wear resistance. Suitable for traction motors.
	TH-03	1.75	68	40	35	M	M	35	10	
	351A	1.63	49	47	22	H	M	40	10	Standard material for commutation brushes. Suitable for medium capacity DC motors.
	641	1.64	59	75	12	H	M	40	10	Suitable for difficult commutation high capacity DC motors and universal motors.
Graphite	402	1.71	24	10	18	M	M	25	10	Has film adjusting effect. Suitable for thick film slip rings.
	801	1.65	30	35	19	M	M	45	15	Good wear resistance. Suitable for pump motors for power steering.
	TR-52	1.74	30	14	16	M	M	40	12	Better commutation performance than 788. Suitable for forklifts of 48V or more.
	TR-19	1.51	33	200	19	M	M	40	12	Good wear resistance. Suitable for 3-phase commutator motor.

* Coefficient of friction: H···0.25 or greater M···0.20-0.25 (Measuring conditions/Slip ring: Copper; Speed: 9.3 m/second; Current: 0 A)
* Contact voltage drop: M···0.5-1.0 V/unit (Measuring conditions/Slip ring: Copper; Speed: 9.3 m/second; Current: DC10 A/cm sq.)
* The above figures are typical values, and are not guaranteed.

Maximum peripheral speed and maximum current density differ depending on the commutator and slip ring conditions and conditions of use. The information listed to the right and above represents general examples. Before choosing a product, consult with our staff about your particular needs.

Composition	Grade	Bulk Density	Hardness	Electrical Resistivity	Flexural Strength	Cofficient of friction	Contact voltage drop	Max. peripheral speed	Max. current density	Features/applications
		g/cm³	HSC	μΩ·m	MPa		V	m/s	A/cm²	
Copper Graphite I	M-90	6.30	15	0.32	108	M	VL	20	25	High strength copper alloy type. Suitable for contacts and grounds.
	M-1T	6.19	13	0.27	108	M	VL	22	22	
	M-2T	5.70	15	0.50	80	M	VL	25	20	
	M-1H	6.83	6	0.04	87	M	VL	25	20	High copper content. Very low temperature rise and contact voltage drop. Suitable for high electrical capacity generators and motors.
	M-1	5.41	12	0.08	42	L	VL	30	25	
	M-1F	5.30	18	0.15	49	L	VL	30	25	
	M-2H	4.93	13	0.10	34	L	VL	30	20	
	M-2HF	4.80	18	0.33	44	M	VL	30	20	
	M-2	4.40	15	0.50	29	L	VL	30	20	The copper content amount is next to M1, M-2H class and has good wear resistance. Suitable for large capacity generators and slip rings for general rotary machine.
	M-2F	4.35	15	0.50	44	M	VL	30	20	
	M-3H	4.04	16	0.70	29	M	VL	30	18	
	M-3HF	4.05	20	0.60	44	M	VL	30	18	
	M-3	3.78	17	1.00	29	L	VL	30	18	
	M-4	3.48	17	2.00	25	L	L	30	18	Middle grade between graphite and metal graphite and has features of both. In particular, it is superior in roughing resistance. It is applicable for small/med capacity generators and motors.
	M-550	2.96	25	2.50	39	M	L	35	15	Good wear resistance. Particularly suitable for stainless steel slip rings.
	M-750	2.32	23	6.00	32	M	L	35	15	
	788	2.02	23	9.00	23	M	M	45	12	Good dimensional stability in high temperature. Suitable for forklifts of 48V or less.
	M-2TB	5.74	12	0.48	65	M	VL	25	20	Same application as the above M-1 and M-2. But does not contain lead.
	M-1B	5.30	10	0.10	43	L	VL	30	25	
	M-2B	4.34	13	0.28	31	L	VL	30	20	
Copper Graphite II	MF-302	2.65	18	3.00	23	M	L	30	20	Suitable for automobile DC12V fan.
	MF-501	3.00	20	0.90	28	L	L	30	20	Suitable for automobile DC12V winch.
	MF-101	2.90	18	2.20	28	M	L	30	20	Suitable for DC19.2V cleaners.
	MF-202	2.05	10	38.0	23	H	M	30	15	
	MF-203	2.05	10	30.0	23	L	M	30	15	
	MF-301	2.40	15	10.0	23	M	M	30	20	Suitable for DC24V cleaners.
	MF-401	2.67	18	10.0	21	M	M	30	20	Suitable for DC19.2V cleaners.
	MF-204	3.78	15	0.30	40	M	L	30	25	Suitable for DC7.2V power tools.
	MF-205	3.00	20	0.80	28	M	L	30	20	Suitable for DC24V power tools.
	MF-701	2.26	18	10.0	30	M	M	30	20	Suitable for DC22-36V power tools.
	MF-201	2.25	10	30.0	23	M	M	30	15	Suitable for household coffee mills.
	MF-601	2.05	10	50.0	23	M	M	30	15	Suitable for electric wheelchair.

* Coefficient of friction: H···0.25 or greater M···0.20-0.25 L···0.20 or less (Measuring conditions/Slip ring: Copper; Speed: 9.0 m/second; Current: 0 A)
* Contact voltage drop: M···0.5-1.0 V/unit, L···0.25-0.50 V/unit; VL: 0.25 or less/unit (Measuring conditions/Slip ring: Copper; Speed: 9.0 m/second; Current: DC10 A/cm sq.)
* The above figures are typical values, and are not guaranteed.

Typical Properties

Composition	Grade	Bulk Density	Hardness	Electrical Resistivity	Flexural Strength	Coefficient of friction	Contact voltage drop	Max. peripheral speed	Max. current density	Features/applications
		g/cm³	HSC	μΩ·m	MPa		V	m/s	A/cm²	
Silver graphite	SX-50	3.20	15	2.70	29	M	VL	20	12	Very low temperature rise and contact voltage drop. Suitable for low current tachometers and grounds contacts.
	SX-70	4.45	15	0.25	40	M	VL	20	15	
	SX-90	6.85	18	0.05	84	M	VL	20	22	

* Coefficient of friction: M···0.20-0.25 (Measuring conditions/Slip ring: Copper; Speed: 9.0 m/second; Current: 0 A)
* Declining contact voltage: VL···Less than 0.25 V/unit (Measuring conditions/Slip ring: Copper; Speed: 9.0 m/s; Current: DC10 A/cm sq.)
* The above figures are typical values, and are not guaranteed.

Composition	Grade	Bulk Density	Hardness	Electrical Resistivity	Flexural Strength	Coefficient of friction	Contact voltage drop	Max. peripheral speed	Max. current density	Features/applications
		g/cm³	HSC	μΩ·m	MPa		V	m/s	A/cm²	
Resin bounded graphite	X-03	1.50	12	200	15	L	H	54	20	Goode ridability. Suitablle for 100-120V high efficiency cleaners.
	X-09	1.52	14	260	15	L	H	54	20	
	X-17	1.54	15	330	18	L	H	54	20	
	X-72	1.47	19	380	14	L	H	48	20	
	X-87	1.50	17	380	22	L	H	54	20	
	X-88	1.52	14	360	20	L	H	54	20	
	X-05	1.48	15	400	18	L	H	50	20	Goode ridability. Suitablle for 100-120V high input cleaners.
	X-10	1.52	15	270	17	L	H	50	20	
	X-78	1.51	17	370	22	L	H	48	20	
	X-80	1.51	17	360	22	L	H	48	20	
	X-13	1.48	19	700	22	L	H	50	15	Good commutation performance. Suitable for 120-240V cleaners.
	X-85	1.48	20	400	14	L	H	48	20	
	X-89	1.53	19	350	21	L	H	48	20	
	X-93	1.50	18	640	27	L	H	50	15	
	X-95	1.51	19	640	24	L	H	50	15	
	X-97	1.45	19	430	14	L	H	50	20	
	X-11	1.35	15	1100	14	L	VH	54	13	Good commutation performance. Suitable for 200-240V cleaners.
	X-73	1.52	24	920	24	L	VH	40	13	
	X-91	1.35	15	1100	17	L	VH	54	13	
	X-94	1.36	14	1200	17	L	VH	54	13	
	X-04	1.36	17	1600	11	L	VH	54	10	Good commutation performance. Suitable for 200-240V cleaners, small motors.
	X-08	1.29	14	1600	14	L	VH	54	10	
	X-96	1.31	14	1600	16	L	VH	54	10	
	B-2	1.75	25	390	24	L	H	25	8	Suitable for juicers, dryers. Moldable by press to size up to 18 mm length max.

* Coefficient of friction: L···Less than 0.20 (Measuring conditions/Current density: AC10 A/cm sq.; Speed: 20 m/second; Spring pressure: 50 kPa)
* Contact voltage drop: VH···Greater than 3.0 V/unit; H···2.0-3.0 volts/unit (Measuring conditions/Current density: AC10 A/cm sq.; Speed: 20 m/second; Spring pressure: 50 kPa)
* The above figures are typical values, and are not guaranteed.

Composition	Grade	Bulk Density	Hardness	Electrical Resistivity	Flexural Strength	Coefficient of friction	Contact voltage drop	Max. peripheral speed	Max. current density	Features/applications
		g/cm³	HSC	μΩ·m	MPa		V	m/s	A/cm²	
Carbon graphite	C-3	1.62	35	240	24	L	H	35	13	Comparative low resistivity. Suitable for 100-120V power tools.
	107	1.62	34	100	29	L	H	35	13	
	113	1.58	37	290	27	L	H	35	13	
	C-1	1.49	30	330	13	L	H	35	12	Suitable for 100V-120V and 200-240V cleaners.
	TX-174	1.55	36	390	24	L	H	35	18	Good commutation performance, wear resistance. Good breaking action. Suitable for 100-120V and 200-240V power tools and cleaners.
	105S	1.55	36	390	24	L	H	35	18	
	108	1.55	36	390	24	L	H	35	18	
	110	1.54	37	350	20	L	H	35	13	
	118	1.64	34	390	23	L	H	35	18	
	129	1.64	34	620	20	L	H	35	18	
	106	1.52	33	680	15	M	VH	35	13	Good commutation performance and wear resistance. Suitable for 200-240V cleaners.
	111	1.61	37	600	23	M	VH	35	13	
	114	1.62	35	900	20	M	VH	35	13	Good commutation performance. Suitable for 200-240V power tools and washing machines.
	122	1.62	42	840	22	M	VH	35	13	
	124	1.60	47	790	26	M	VH	35	13	
	127	1.53	33	850	21	M	VH	35	13	
	116	1.62	35	900	20	M	VH	35	13	Good commutation performance and wear resistance. Suitable for 200-240V power tools.
	119	1.59	42	1300	20	M	VH	35	13	Good commutation and sliding performance. Suitable for 200-240V power tools and washing machines.
	B-1	1.75	47	450	13	L	H	25	8	Suitable for small power tools and juicers. Moldable with lead wire by press to size up to L12 mm max.
	C-2	1.55	44	660	17	L	H	25	10	Suitable for small power tools and juicers. Moldable with lead wire by press to size up to L15 mm max.
	C-2N	1.58	18	660	14	L	H	25	10	Suitable for small power tools and juicers. Moldable with lead wire by press to size up to L15 mm max. Better noise prevention and film adjusting effect than C-2.
	FX-08	1.66	32	590	19	L	H	25	10	Suitable for small power tools and juicers. Moldable with lead wire by press to size up to 18 mm max. Better noise prevention and film adjusting effect than C-2.

* Coefficient of friction: M···0.20-0.25, L···Less than 0.20
  (Measuring conditions/Current density: AC10 A/cm sq.; Speed: 20 m/second; Spring pressure: 50 kPa)
* Contact voltage drop: VH···Greater than 3.0 V/unit; H···2.0-3.0 volts/unit
  (Measuring conditions/Current density: AC10 A/cm sq.; Speed: 20 m/second; Spring pressure: 50 kPa)
* The above figures are typical values, and are not guaranteed.

Maximum peripheral speed and maximum current density differ depending on the commutator and slip ring conditions and conditions of use. The information listed to the left and above represents general examples. Before actually using one of our products, please be sure to contact our sales department to consult on selecting the most appropriate grade.

Design Data

■ Reference: methods to mount lead wire and shape of carbon brush (JIS C2802)

C1 No lead wire	 C1-1	 C1-2	 C1-3	 C1-4	 C1-5	 C1-6	 C1-7	 C1-8	 C1-9	 C1-10
C2 Copper powder tamped soldering	 C2-1	 C2-2	 C2-3	 C2-4	 C2-5	 C2-6	 C2-7	 C2-8	 C2-9	 C2-10
	 C2-11	 C2-12								
C4 Copper pipe (one) Ribetting	 C4-1	 C4-2	 C4-3	 C4-4	 C4-5	 C4-6	 C4-7	 C4-8	 C4-9	 C4-10
	 C4-11	 C4-12	 C4-13	 C4-14	 C4-15	 C4-16	 C4-17	 C4-18	C4-19	C4-20
	C4-21									
C5 Copper pipe (two) Ribetting	C5-1	C5-2	C5-3	C5-4	C5-5	C5-6	C5-7	C5-8	C5-9	C5-10
	C5-11	C5-12	C5-13	C5-14	C5-15	C5-16	C5-17	C5-18		
C6 Segmented rhomboid	C6-1	C6-2	C6-3	C6-4						

■ Tolerance for Thickness, Width, and Length (JIS C2802)

Tolerance for the thickness, width, and length of the brush as well as that of the inner dimensions of the brush holder are as follows:

Unit: mm

Nominal Dimensions	Brush thickness/width tolerance		Holder inner dimension tolerance		Space between brush/holder		Brush length tolerance
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	
1.6 / 2 / 2.5	-0.09	-0.03	+0.05	+0.01	0.14	0.04	±0.3
3.2	-0.09	-0.03	+0.07	+0.02	0.16	0.05	±0.3
4 / 5	-0.11	-0.03	+0.07	+0.02	0.18	0.05	±0.3
6.3 / 8 / 10	-0.11	-0.03	+0.09	+0.03	0.20	0.06	±0.3
12.5 / 16	-0.13	-0.04	+0.10	+0.03	0.23	0.07	±0.5
20 / 25	-0.13	-0.04	+0.12	+0.04	0.25	0.08	±0.5
32 / 40 / 50	-0.15	-0.05	+0.15	+0.05	0.30	0.10	±0.8
64 / 80	-0.15	-0.05	+0.18	+0.06	0.33	0.11	±0.8
100 / 125	—	—	—	—	—	—	±1.0

* Segment brush thickness tolerance of up to 0.02 mm is permissible unless otherwise specified.
  However, note that the maximum dimensions of the brush cannot be altered.

Display example $16^{-0.04}_{-0.15} \times 25^{-0.04}_{-0.13} \times 40^{\pm 0.8}$ (two pieces)

* For brushes that has higher thermal expansion, such as metal graphite brushes, the heat expansion dimensions of the above nominal dimensions can be reduced and the above tolerance applied. This is up to the discretion of the manufacturer, and agreement must be reached with the user.
  Note that the nominal dimensions in such cases will be displayed as in the table. Letters “a” and “b” in the examples refer to heat expansion.

Display example $16^{-(0.14+a)}_{-(0.13+a)} \times 25^{-(0.04+b)}_{-(0.13+b)} \times 40^{\pm 0.8}$

* Tolerance for the inner dimensions of the holder apply to brush thickness and width direction for the perpendicular-shaped holder.
  However, for items such as backlash holders, which do not depend on the interval between brush and holder for brush stability, the maximum specification of the interval thickness direction can be altered upon agreement with the user.

Design Data

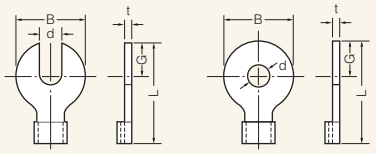
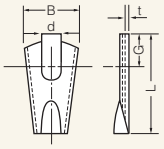
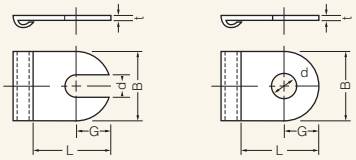
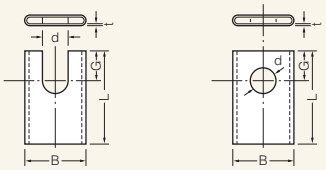
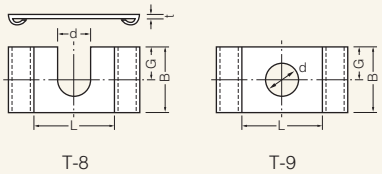
■ Lead Wire Structure (JIS C2802)

Nominal cross-section mm²	Recommended values								Reference
	Maximum OD	Minimum weight	Independent wire diameter 0.05 mm		Independent wire diameter 0.08 mm		Independent wire diameter 0.10 mm		Allowable current +15% -10%
			Number of wires/wire diameters	Cross-section calculation	Number of wires/wire diameters	Cross-section calculation	Number of wires/wire diameters	Cross-section calculation	
	mm	g/m	mm	mm²	mm	mm²	mm	mm²	A
0.06	0.5	0.48	3/10/0.05	0.06	12/0.08	0.06	—	—	2
0.10*	0.6	0.72	3/17/0.05	0.10	20/0.08	0.10	—	—	3
0.15*	0.7	1.00	3/26/0.05	0.15	30/0.08	0.15	—	—	4
0.20*	0.8	1.40	3/34/0.05	0.20	40/0.08	0.20	—	—	4.8
0.25	1.0	2.00	3/42/0.05	0.25	3/17/0.08	0.26	—	—	5.5
0.30	1.1	2.20	3/51/0.05	0.30	3/20/0.08	0.30	—	—	6
0.35	1.1	2.80	3/60/0.05	0.35	3/23/0.08	0.35	3/15/0.10	0.35	7
0.40	1.2	2.90	—	—	3/27/0.08	0.41	3/17/0.10	0.40	8
0.50	1.3	4.00	—	—	3/33/0.08	0.50	3/21/0.10	0.49	9
0.75*	1.6	5.60	—	—	3/50/0.08	0.75	3/32/0.10	0.75	12
0.90	1.7	6.50	—	—	7/26/0.08	0.91	7/16/0.10	0.88	13
1.00	1.8	8.00	—	—	7/28/0.08	0.99	7/18/0.10	0.99	15
1.25	2.0	10	—	—	7/36/0.08	1.27	7/23/0.10	1.26	17.5
1.40	2.1	11	—	—	7/40/0.08	1.41	7/25/0.10	1.37	19
1.50*	2.2	13	—	—	7/43/0.08	1.51	7/27/0.10	1.48	20
2.00	2.4	16	—	—	7/57/0.08	2.01	7/36/0.10	1.98	24
2.50	2.7	20	—	—	7/71/0.08	2.50	7/46/0.10	2.53	28
3.20	3.0	26	—	—	7/91/0.08	3.20	7/58/0.10	3.19	32
3.50	3.2	28	—	—	7/100/0.08	3.52	7/64/0.10	3.52	34
4.00	3.3	32	—	—	7/114/0.08	4.01	7/73/0.10	4.01	38
4.50	3.5	36	—	—	7/127/0.08	4.47	7/82/0.10	4.15	40
5.50	3.7	44	—	—	7/157/0.08	5.52	7/100/0.10	5.50	45
6.00	4.2	48	—	—	7/170/0.08	5.98	7/109/0.10	5.99	50
6.50	4.4	52	—	—	—	—	7/119/0.10	6.54	53
8.00	4.7	64	—	—	—	—	7/146/0.10	8.03	60
10.00	5.3	80	—	—	—	—	7/182/0.10	10.01	75
12.50	5.9	100	—	—	—	—	7/7/32/0.10	12.32	85
16.00	6.7	128	—	—	—	—	7/7/42/0.10	16.16	100

* Figures based on JIS C3664 standards (IEC60228).
* The material of lead wire having 0.05/0.08 mm independent diameter is based on JIS 3103 while lead wire having 0.10 mm independent diameter is based on JIS3102.
* Where the lead wire is fitted into a tube, lead wire thickness can be adjusted upon agreement with the user.
* Where there is a possibility of excess current or insufficient cooling capability, adjust the lead wire thickness upon agreement with the user.

■ Terminal shape and dimensions (JIS C2802)

Unit: mm

Number	Dimensional diagrams	Installation screw (meter screw)	Dimensions				
			d	B	G	L	t
T-1 T-2	 T-1 T-2	3	3.5 +0.2 −0.2	8 ± 0.3	4	12 ± 1	0.5 0.8
		4	4.5 +0.3 −0.1	10 ± 0.3	5	15 ± 1	0.8
		5	5.5 +0.3 −0.1	13 ± 0.4	6.5	20 ± 1	0.8 1.0
		6	6.5 +0.3 −0.1	16 ± 0.4	8	24 ± 1	1.0
		8	8.5 +0.3 −0.1	19 ± 0.5	9.5	29 ± 1	1.0 1.2
		10	10.5 +0.3 −0.1	23 ± 0.5	12	40 ± 1	1.2
T-13	 T-3	5	5.5 +0.3 −0.1	13 ± 0.8	6.5	20 ± 1.5	0.4 0.5
		6	6.5 +0.3 −0.1	16 ± 0.8	8	24 ± 1.5	0.4 0.5
		8	8.5 +0.3 −0.1	19 ± 1	9.5	29 ± 1.5	0.4 0.5
T-4 T-5	 T-4 T-5	3	3.5 +0.2 −0.2	8 ± 0.3	4	> 8	0.5 0.8
		4	4.5 +0.3 −0.1	10 ± 0.3	5	> 10	0.8
		5	5.5 +0.3 −0.1	13 ± 0.4	6.5	> 13	0.8 1.0
		6	6.5 +0.3 −0.1	16 ± 0.4	8	> 16	1.0
		8	8.5 +0.3 −0.1	19 ± 0.5	9.5	> 19	1.0 1.2
		10	10.5 +0.3 −0.1	23 ± 0.5	12	> 25	1.2
T-6 T-7	 T-6 T-7	5	5.5 +0.3 −0.1	13 ± 0.8	6.5	20 ± 1	0.4 0.5
		6	6.5 +0.3 −0.1	16 ± 0.8	8	24 ± 1	0.4 0.5
		8	8.5 +0.3 −0.1	19 ± 1	9.5	29 ± 1	0.6 0.8
		10	10.5 +0.4 −0.1	23 ± 1	11.5	35 ± 1	0.6 0.8
T-8 T-9	 T-8 T-9	4	4.5 +0.3 −0.1	10 ± 1	5	> 10	0.8 1.0
		5	5.5 +0.3 −0.1	14 ± 1	7	> 12	0.8 1.0
		6	6.5 +0.3 −0.1	16 ± 1	8	> 14	1.0 1.2
		8	8.5 +0.3 −0.1	20 ± 1	10	> 18	1.0 1.2
		10	10.5 +0.3 −0.1	23 ± 1	12	> 26	1.2

* Where there is no tolerance indicated (excluding t), it is the G dimension ±10%
* The t dimensions for T-8 can be 1.2 for screw numbers 4 and 5, and 1.5 for screw numbers 6 and 8.