KUREHA CORPORATION

Carbon Products Department
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Note

The numerical values presented in this brochure are representative values, not guaranteed values.
Though the term "Ultra-high purity" is used in regard to purity, this refers to grades compared within the company.
Please verify the regulations corresponding to the purpose and application, product safety, and other such details when using products.
Safety Data Sheets (SDS) have been prepared separately in regard to handing precautions. Please contact our representative.
In addition, when handling products, please use them taking note of the points below.

1. Since carbon fibers are electrically conductive, it is recommended that dust control measures are implemented to prevent short circuiting of electrical equipment at the workplace site.
2. It is recommended that a mask and gloves be worn during handling to prevent the breathing in of material or skin coming in contact with the material.
3. When disposing the material, be sure to treat it as "Industrial Waste".

20191031-03

KURECA

KRECA

KRECA Carbon Fiber

Kureha is a carbon material manufacturer with sales worldwide.

We, Kureha, are commonly known for household goods such as NEW Krewrap. Our business includes a wide variety of products, for example advanced materials, pharmaceuticals, agricultures, and packing plastics. Carbon fiber is one of our main businesses. We continually support the industry as the pioneer who first developed pitch type carbon fiber in the world. Kureha's carbon fiber products are also known in the global market for its high quality.

History

1944	Spin off from Kureha Cotton Spinning
1953	Started production of polyvinylidene chloride
1960	Launched "Krewrap" to the market
1969	Developed world's first technology of Crude oil thermal cracking process
1970	Launched carbon fiber "KRECA" to the market
1972	Launched bead-shaped activated carbon "BAC" to the market
1977	Launched anti-cancer agent "Krestin" to the market
1987	Launched engineering plastic "Fortron KPS" to the market
1989	Launched "NEW Krewrap" to the market
1991	Launched therapeutic agent for chronic kidney disease "Kremezin" to the market
1993	Launched agricultural fungicide "Metoconazole", seed treatment fungicide "Ipconazole", carbon material for lithium ion secondary batteries "Carbotron P" and PVDF binder for lithium ion secondary batteries "KF polymer" to the market.
2000	Launched fine grain agent "Kremezin" to the market
2005	Changed the company name from Kureha Chemical Industry Co., Ltd to Kureha Corporation
2012	Started operation of industrial Scale PGA (Polyglycolic Acid) manufacturing facility

Usage example of "KF polymer" as pipe valve

Usage example of "Fortron KPS" as water pump impeller

"NEW Krewrap"

Industrial salt, raw material of the Kureha product lineup

INDEX

Basic Properties and Product Lineup of KRECA

As a pioneer of petroleum pitch type carbon fiber, Kureha's carbon fiber "KRECA" is desired by the worldwide industry for its high purity, flexibleness, and variety of types.

Features of Kureha's Carbon Fiber "KRECA"

Knowledge of the world's pioneer

In 1970, Kureha industrialized pitch type carbon fiber for the first time in history. Since then, our innovative technology has been satisfying the challenging and various requirements of our customers all over the world.

High purity products

KRECA carbon fiber is made from petroleum pitch, which has low metal impurity. Therefore, it is superior in oxidation resistance and has a longer lifetime inside a furnace.

Produced using an integrated process from raw material.

Kureha produces carbon fiber through an integrated process from raw material pitch, which is then chopped, milled, felt punched, and machined for the insulation we manufacture. Therefore, we achieve flexible and sustainable production with high quality results.

Various product lineup

KRECA has various product lineup such as yarn, felt, chopped fiber, and rigid felt to accommodate various needs.

Received certificates of quality control and environmental management system.

Kureha's mother factory in Iwaki, Japan obtained quality control standard ISO9001 and environmental management system standard ISO14001.

Basic Characteristics of KRECA

Basic Physical Properties of KRECA

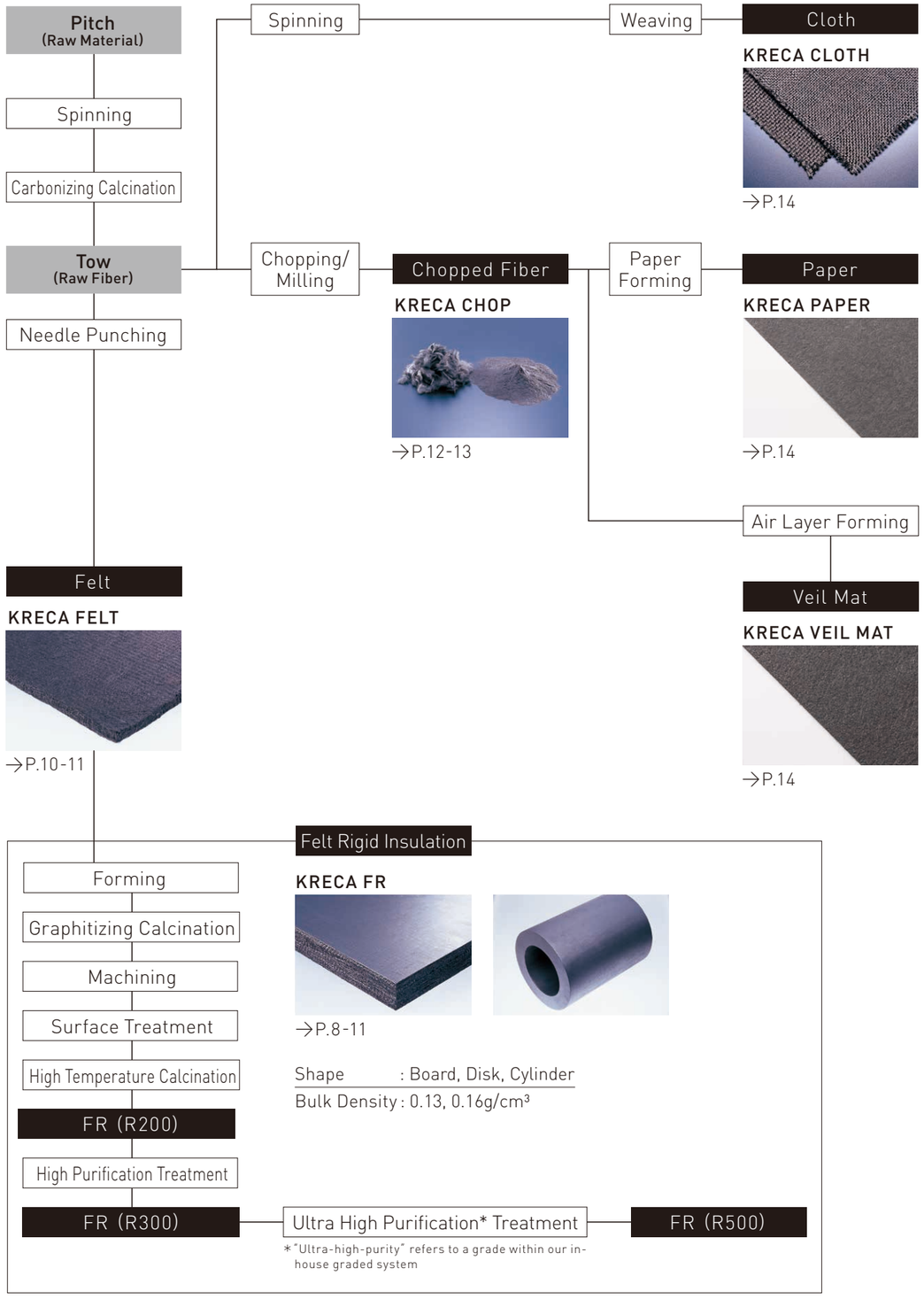
measuring method: Kureha standard test method

Fiber Diameter Classification		Carbon Fiber KCF-100			Graphite Fiber KGF-200	
		F	S	T	F	S
Fiber Diameter	μm	12.5	14.5	18.0	12.5	14.5
Tensile Strength	MPa	850	800	670	850	800
Tensile Elastic Modulus	GPa	37	35	30	37	35
Elongation	%	2.3	2.3	2.2	2.3	2.3
Carbon Content	wt %	min 95			min 99	
Thermal Conductivity	W/m/K	5～10			100	
Coefficient of Linear Expansion	$\times 10^{-6}$/K	3～5			1.7	
Electrical Resistivity	μΩ·m	150			50	
Specific Gravity		1.63			1.60	
Moisture Content	wt %	max 12			0	
Oxidation Onset Temperature*	℃	310			390	

* Temperature at which weight reduction is 1% when held 24 hours

Process Flow Diagram of KRECA Production

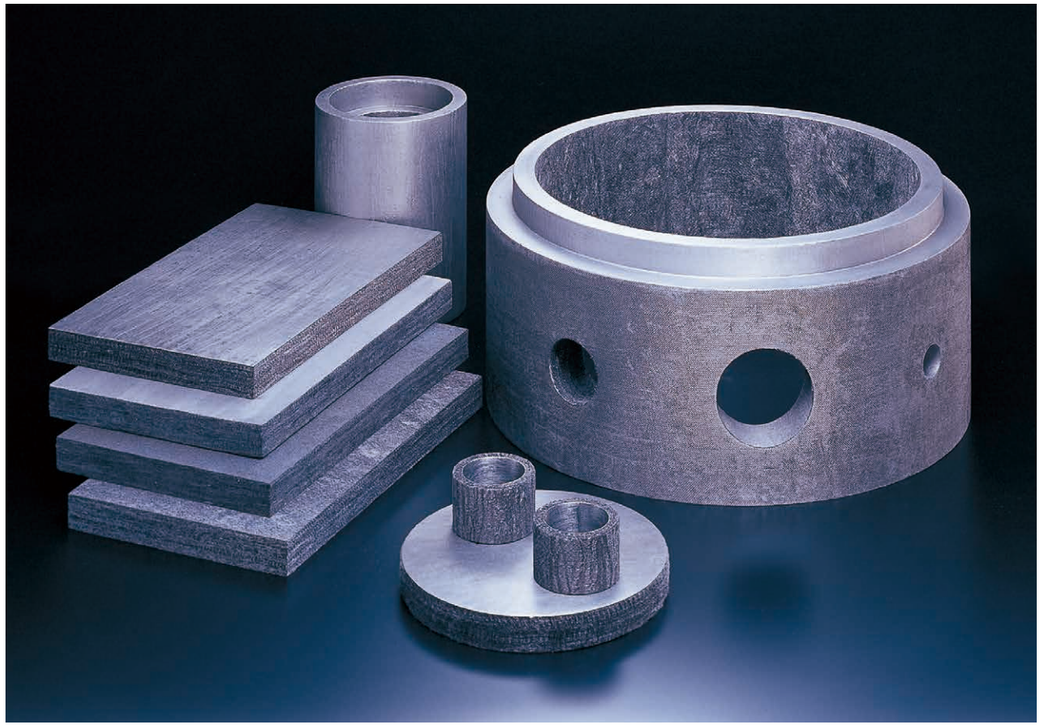
raw material / product / process



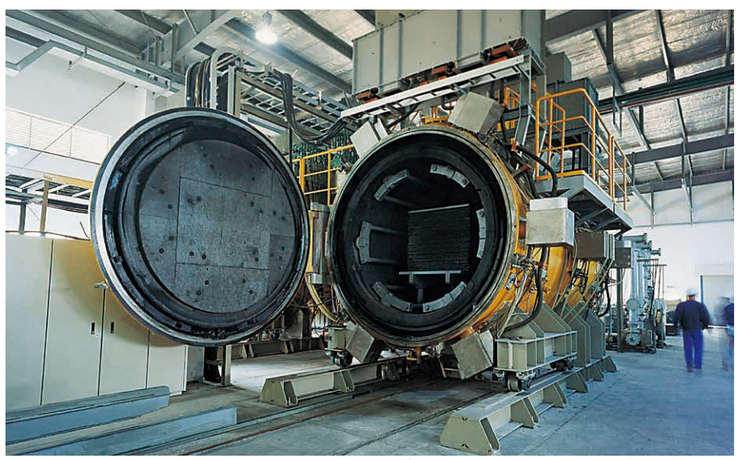
Thermal Insulation Materials for High-temperature Furnaces
KRECA FR

About the Product

- KRECA FR, which function as excellent insulation, are products for use in furnaces with high-temperature closed atmosphere. The graphitized carbon-fiber insulation is manufactured by forming carbon fiber felt into the desired shapes, such as boards, discs, and cylinders, with a small quantity of binder.



Examples of KRECA FR Shapes
We will meet and respond to the various needs of our customers' desires about shapes of KRECA FR.



Large Sintering Furnace for Carbon-fiber Insulation (Kureha (Shanghai) Carbon Fiber Materials Co., Ltd.)

Main Usages or Applications

- Insulation for furnaces that manufacture multicrystalline silicon ingots
- Insulation for furnaces that manufacture sapphire ingots or optical-fiber preforms
- Insulation for monocrystalline silicon ingot pulling furnaces
- Insulation for sintering or heat treating furnaces

Features

- Our insulation has superior thermal properties and high stability in high-temperature atmosphere.
- Our insulation is light-weight yet solid enough to stand by itself. Complex machining is available as well.
- Kureha handles all the manufacturing process of the products, which allows the quality to be well-controlled throughout the manufacturing process.
- Various types of surface treatments are available to meet the customers' requirements.
- Our insulation is less dusty compared to felt-formed insulation.

Installation Advantages

- Since KRECA FR is light-weight and easily machined into customers' desired shapes, it is easily handled or placed, which reduces maintenance downtime.
- We can support customers by providing insulation, which is customized according to their needs for thermal properties, surface treatments, product purity, and other requirements. Customers can freely design KRECA FR to match their usage or conditions inside their furnaces.
- We can offer surface treatments which best match requirements such as prevention of dust or improvement of gas-sealing.
- High purity of the KRECA FR and highly-controlled processes of the KRECA FR production prevent contamination.

Specifications of KRECA FR

Types and Grades

〈ex.-1〉 **R - 20 0 - 0.13** [Standard type with no surface treatment, bulk density of 0.13g/cm³]
A B D

〈ex.-2〉 **R - 30 3 /OS - 0.16** [High-purity type treated with graphite cloth and OS coating on the surface, bulk density of 0.16g/cm³]
A B C D

	References	Specifications
A **Purity**	20	Standard type
	30	High-purity type
	50	Ultra-high-purity type
B **Surface Treatment-1** (applying)	0	No surface treatment
	2	Graphite foil attached on the surface
	3	Graphite cloth attached on the surface
	5	Hybrid graphite cloth attached on the surface
C **Surface Treatment-2** (coating)	/OS	Special graphite coating (OS coating) on the surface
	/OS/PG	OS coating and pyrolytic graphite treatment on the surface
D **Bulk Density**	0.13	Bulk density 0.13g/cm³
	0.16	Bulk density 0.16g/cm³

Typical Physical Properties and Characteristics of KRECA FR

measuring method: Kureha standard test method

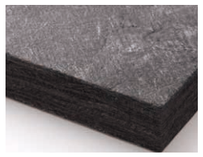
Bulk Density			g/cm³	0.13	0.16
Min. Carbon Content			wt %	＞99	＞99
Ash	Standard Type	(R200)	ppm	130	130
	High-Purity Type	(R300)		15	15
	Ultra-High-Purity Type	(R500)		2	2
Compressive Strength (5%Deformation)	Surface Direction		MPa	0.40	0.50
	Thickness Direction			0.12	0.15
Flexural Strength (Bending Strength)	Surface Direction		MPa	1.5	1.7
	Thickness Direction			0.7	0.9
Electrical Resistivity	Surface Direction		Ω·m	5.6×10^{-3}	5.3×10^{-3}
	Thickness Direction			19.9×10^{-3}	18.9×10^{-3}
Average Thermal Conductivity*	in Vac.		W/m/K	0.41	0.36
	in N_2			0.50	0.45
Coefficient of Thermal Expansion	0-1000℃		$\times10^{-6}$/K	2.5	2.5
	1000-2000℃			3.0	3.0

＊At 1,500 degrees Celsius, test pieces with 70mm thickness

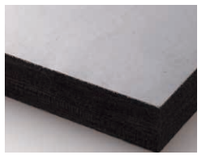
Types and Effects of Surface Treatments

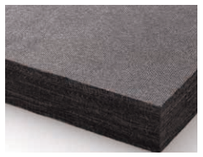
Surface Treatments \ Features and Functions	As Fuzz Prevention, Dust Prevention	As Gas-Sealing (Controlling of Gas Permeation)	As Surface Protection (Slowing of Deterioration)	As Reinforcement for Strength against Shocks
No Surface Treatment	-	-	-	-
With Special Graphite Coating(OS Coating)*1	○	-	○	-
With Graphite Foil Attached	◎	○	○	-
With Graphite Cloth Attached	○	-	○	○
With Hybrid Graphite Cloth Attached	○	-	◎	◎
With OS Coating and Pyrolytic Graphite Treatment *2	◎	◎	◎	◎

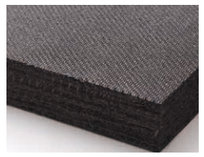
＊1 OS coating is Kureha's special graphite coating.
＊2 PG treatments are only done on the "High-purity" and "Ultra-high-purity" grades.


No Surface Treatment

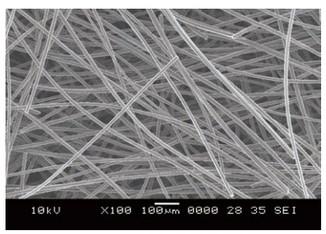

Special Graphite Coating (OS Coating)


Graphite Foil Attached

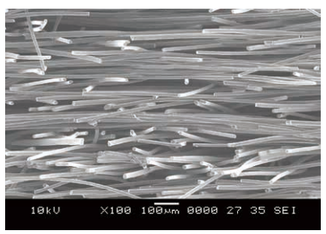

Graphite Cloth Attached


Hybrid Graphite Cloth Attached

The Fiber Orientation of KRECA FR

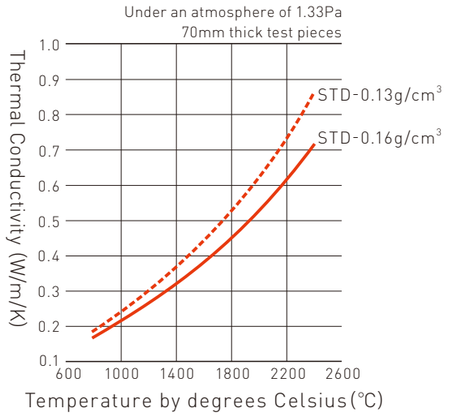


Appearance of the KRECA FR Surface (parallel to laminated surface)



Appearance of the KRECA FR Surface (perpendicular to laminated surface)

Average Thermal Conductivity (in Vac.)



Impurities Contained in KRECA FR

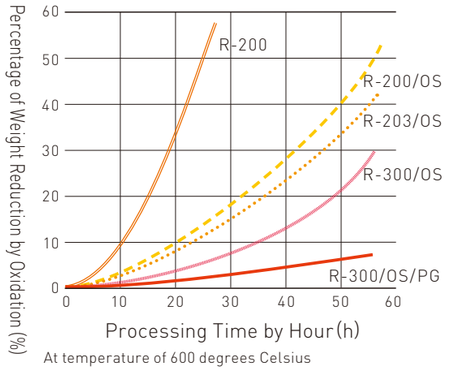
Unit : ppm

Properties \ Grades	Standard Type		High-Purity Type	Ultra-High-Purity Type
	R-200/OS*1	R-200	R-300/OS	R-500/OS
Ash	170	138	＜15	＜5
Al	3.51	3.92	0.12	＜0.05
Ca	11.1	12.1	0.16	＜0.05
Cu	0.40	0.33	＜0.05	＜0.05
Fe	3.16	1.97	0.18	0.09
Ni	0.27	0.33	＜0.1	＜0.05
Si	57.2	42.7	1.33	0.28
Ti	4.00	3.77	2.41	＜0.05
P	＜1	＜1	＜1	＜1
B	4	4	3	2

＊1 Assay of OS coating in R-200/OS weigh around 10% of the insulation itself in average.
＊ Ash content of "High-purity type" and "Ultra-high purity" will not be effected by the surface treatment.

Oxidation Resistance Characteristics of KRECA FR

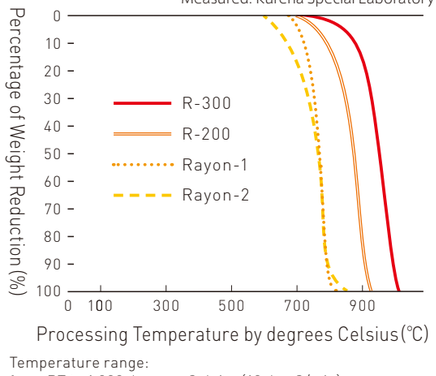
＜Improvement in OxidationResistance Feature by Surface Treatments＞



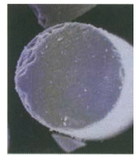
At temperature of 600 degrees Celsius
In air (2L/min)

＜Difference in Oxidation between Types of Carbon Fiber＞

Measured: Kureha Special Laboratory Co., Ltd. Sep. 2000



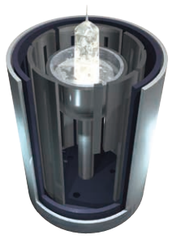
Temperature range:
from RT to 1,000 degrees Celsius (10 deg C/min)
In air (200L / min)


Pitch-based Carbon Fiber


Rayon-based Carbon Fiber

Examples of KRECA FR Usage

KRECA FR works both as frame protection and insulation for crystal-growth devices, such as monocrystalline silicon ingots, compound semiconductors, optical-fiber performs, quartz, sapphire ingots, etc.


Monocrystalline Ingot Puller


Multicrystalline Casting Silicons


PV Panels

Max Sizes Available

Grades	R-200, R-202, R-203
Boards	1800×1800×300T
Discs	ϕ1800×300T
Cylinders	ϕ1800×200T×2000H

＊ Maximum available sizes differ depending on thicknesses. Please feel free to contact us about details.

Carbon Fiber Felt
KRECA FELT

About the Product

- KRECA FELT is felt-formed non-woven fabrics with low density.
  They are formed by needle-punching carbon fibers.
- We have three types of KRECA FELT available; KRECA FELT C, KRECA FELT G, and KRECA FELT X.

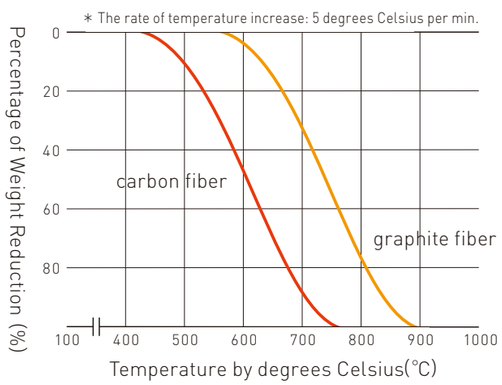
KRECA FELT C and G

KRECA FELT X

Main Usages or Applications

- Insulation for devices of metalizing film by Aluminum vapor deposition, or insulation for furnaces in which the temperature is higher than 1,000 degrees Celsius
- Also used as protections in high-temperature workplaces and in workplaces which use corrosive chemicals

Weight Reduction by Oxidation



Features

- Featuring high-purity properties, KRECA FELT can prevent contamination.
- KRECA FELT is flexible, which enables it to be easily applied as cushions or insertions.
- High uniformity in thickness provides customers with high handling ability and stable quality.

Installation Advantages

- Featuring high-purity properties, KRECA FELT can prevent manufactured goods from contamination, thus contributing to high-quality production of the goods.
- Felt can be used for manufacturing silicon ingots.
- Felt can be used for light maintenance.

Specifications of KRECA FELT

Types and Grades

〈ex.〉 **F - 2 05 X** [Graphite grade / Typical mass of 500g/m² / KRECA FELT X]
A B C

A Purity and Thermal Classification
- 1: Carbon Grade
- 2: Graphite Grade

B Typical Mass (unit: g/m²)
- 05: 500
- 07: 700
- 10: 1000

C Classification by Process
- none: KRECA FELT C or KRECA FELT G
- X : KRECA FELT X

Typical Physical Properties and Characteristics of KRECA FELT

measuring method: Kureha standard test method

			KRECA FELT C		KRECA FELT G		KRECA FELT X		
			F-105	F-110	F-205	F-210	F-205X	F-207X	F-210X
Typical Mass		g/m²	500	1000	500	1000	500	700	1000
Typical Thickness		mm	8	16	8	16	5	7	10
Min. Carbon Content		wt %	＞95		＞99		＞99		
Ash	Standard Type	ppm	＜200		＜200		＜200		
Electrical Resistivity		Ω·m	10～15×10⁻³		4～5×10⁻³		10～15×10⁻³		
Average Thermal Conductivity*	in Vac.	W/m/K	0.27		0.27		0.30		
	in N_2		0.46		0.46		0.50		

＊ At 1,000 degrees Celsius, test pieces with 50mm thickness

Packaging

	Grades of the Products	Packaging Unit	Packaging	Dimensions of Packing by mm
KRECA FELT C	F-105, F-110	1000mm×5m per Roll	Rolled on paper tube, polyethylene wrapped, and packed in cardboard boxes.	1100W×350L×350H
KRECA FELT G	F-205, F-210			
KRECA FELT X	F-205X, F-207X F-210X	1200mm×5m per Roll		1320W×350L×350H

Chopped Fiber
KRECA CHOP

About the Product

- KRECA CHOP is chopped or milled carbon fiber.

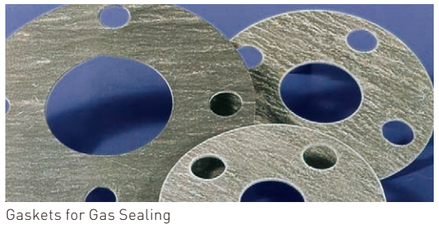
CHOP (left) and MILLED (right)

Main Usages or Applications

- Disk brake pad
- Parts for semiconductor/LCD
- Gaskets for gas sealing, etc.

Disk Brake Pad

Parts for Semiconductor/LCD



Gaskets for Gas Sealing

Features

- Adds properties of petroleum pitch based carbon fiber, such as sliding properties when compounding with resin or synthetic rubber.

Installation Advantages

- It improves corrosion resistance.
- It improves thermal conductivity.

Types and Grades

Specifications of KRECA CHOP

〈ex.〉 **C - 1 03 T** [Chopping by cutter/ Fiber length 3mm/ Carbon fiber/ Thick fiber]

A Classification by Chopping Process

C : CHOP	Chopped by cutter	Average fiber length more than 3mm
M: MILLED	Ground by mill	Average fiber length 0.09mm to 1mm

B Classification by Calcination Process

1: Carbon fiber (KCF-100)
2: Graphitized fiber (KGF-200)

C Classification by Fiber Length

CHOP	MILLED		
03: 3mm	007: 0.09mm	009: 0.1mm	01: 0.15mm
06: 6mm	02: 0.2mm	04: 0.3mm	07: 0.4mm
25: 25mm	25: 1mm		

D Classification by Fiber Diameter

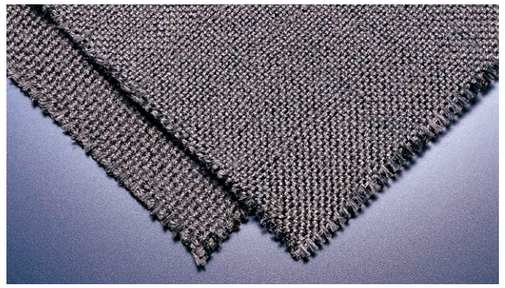
F: Fine fiber	Average diameter 12.5μm
S: Standard fiber	Average diameter 14.5μm
T: Thick fiber	Average diameter 18.0μm

Grades of KRECA CHOP

＊ Grades in bold letters are the major grades

	KCF-100			KGF-200	
Fiber Diameter (μm) / Fiber Length (mm)	12.5	14.5	18.0	12.5	14.5
0.09	-	-	-	-	**M-2007S**
0.1	-	M-1009S	-	-	-
0.15	-	M-101S	M-101T	M-201F	**M-201S**
0.2	-	M-102S	-	-	-
0.3	-	-	**M-104T**	-	-
0.4	-	-	**M-107T**	-	-
1	M-125F	M-125S	M-125T	-	-
3	-	-	C-103T	-	C-203S
6	-	-	C-106T	-	-
25	-	-	C-125T	-	-

Carbon Cloth
KRECA CLOTH



About the Product

- KRECA CLOTH is a carbon fiber cloth of KRECA YARN origin.

Main Usages or Applications

- Base material for carbon fiber composite (CFRP, CFC)
- Surface treatment for KRECA FR

Features

- **Slide Ability** – Cut carbon fiber makes easier to slide
- **Chemical Resistance** – less chemical reaction property
- **Heat Resistance** – suitable under high temperature atmosphere
- **High Strength** – suitable for protective treatment

Installation Advantages

- Suitable to add slide ability in cloth form
- Suitable for protection of target material inside furnace

＜Specifications of KRECA CLOTH＞

measuring method: Kureha standard test method

Grades			P-200	B-300
Weave			plain weave	basket weave
Thickness		mm	0.50	0.6
Standard Mass		g/m²	210	295
Weave Density	Warp	numbers/inch	20	29
	Fill	numbers/inch	18	27
Surface Resistance	Standard Type	Ω/m²	200	150
	Graphitized Type		20	10
Tensile Strength	Warp	kN/5cm	＞0.49	＞0.59
	Fill		＞0.39	＞0.49

Paper / Veil Mat
KRECA PAPER
KRECA VEIL MAT

KRECA PAPER

KRECA VEIL MAT

About the Product

- KRECA PAPER is made from KRECA CHOP using the paper manufacturing process.
- KRECA VEIL MAT is formed by air-layered process using KRECA CHOP as raw material.
- KRECA VEIL MAT is thicker and stronger compared to KRECA PAPER.

Main Usages or Applications

- Carbon paper: lining mat in ceramic baking process, quartz production process, etc. [KRECA PAPER]
- Reinforcement material for plastic and cement [KRECA VEIL MAT]
- Add electrical conductivity and slide ability to the compound [KRECA VEIL MAT]

Features

- **Slide Ability** – Cut carbon fiber makes easier to slide
- **Corrosion Resistance** – reduces corrosion
- **Heat Resistance** – suitable under high temperature
- **High Purity** – low contamination to the product in contact
- **High Affinity** – high affinity to the soaking resin

＜Specifications＞

Products	KRECA PAPER		KRECA VEIL MAT
	E-704	E-525	V-209P
Thickness (mm)	0.3	1.2	2
Standard Mass (g/m²)	40	300	140
Width (mm)	-	-	1000

Manufacturing Sites and Sales Locations for KRECA Products

Kureha Group production and sales network meet the large variety and quantity needs around the world.

Kureha's carbon fiber production network has capacity to meet the large variety of product and mass quantity needs of the customers. We spread our network around the world by establishing production and sales sites for timely supply to the customers.

Features of Production and Sales Network of KRECA Products

International production network

Kureha has three production sites in Iwaki/Japan, Shanghai/China and Pittsburgh/U.S.A. Therefore, we are able to meet international demand rapidly and flexibly.

Sales locations all over the world

Sales subsidiaries in Tokyo/Japan, Duesseldorf/Germany, Texas/U.S.A and Shanghai/China cover major regions of the world to support customers' inquiries on time.

GERMANY
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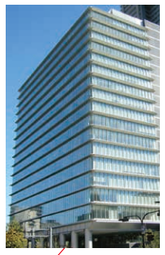

Japan Head Office (S)
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(P) : Production site
(S) : Sales location

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