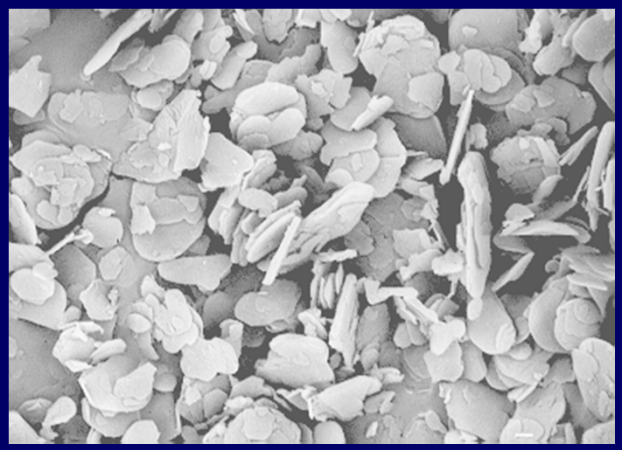
Confidential

Jan, 2017

DENKA BORON NITRIDE POWDER



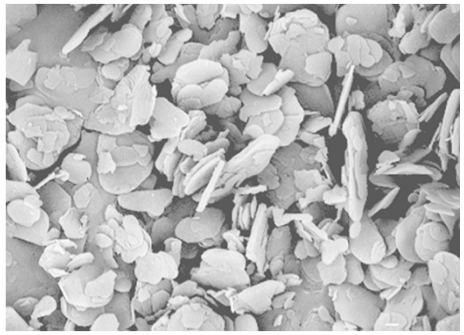
DENKA Company Limited

Electronics & Innovative Products

Advanced Specialty Materials Department

Denka

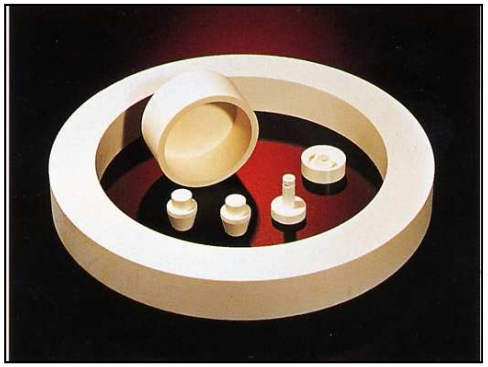
DENKA BORON NITRIDE Family



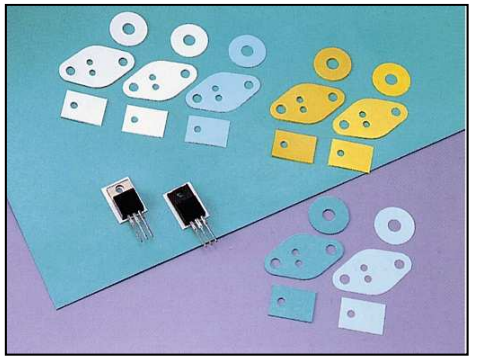
Boron Nitride Powder

Boron Nitride (BN), sometimes called "White Graphite", has much excellent properties. These properties are applied to not only powder products but also sintered products, thermally conductive sheet, and so on.

BN Family



BN Sintered Product



Thermally Conductive Sheet

＜ Applications＞

- ◆BN Powder･･･Solid lubrication, Mold release material , Thermal conductive filler ,Insulation filler, Crystal plastic additive and so on.
- ◆BN Sintered Product･･･Insulator, Solid Boron Dopant Source
- ◆Thermally Conductive Sheet

Denka

Polymorphism of Boron Nitride

Hexagonal BN (hBN)

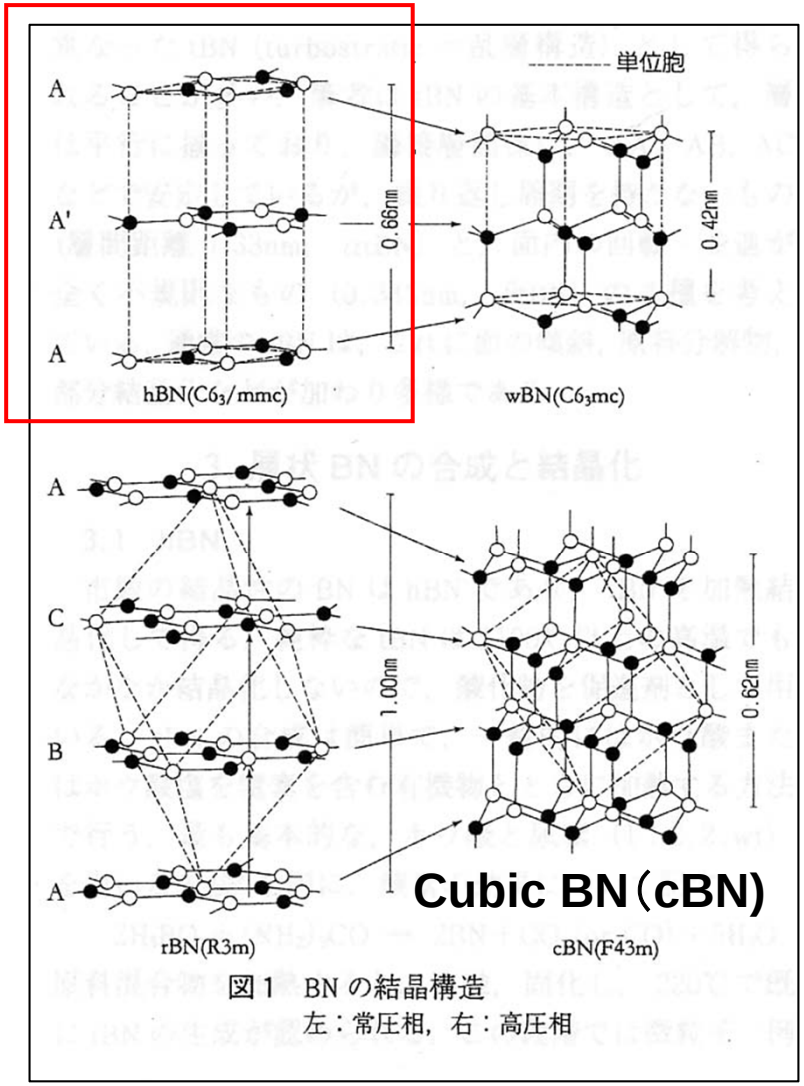


図１　BN の結晶構造
左：常圧相，右：高圧相

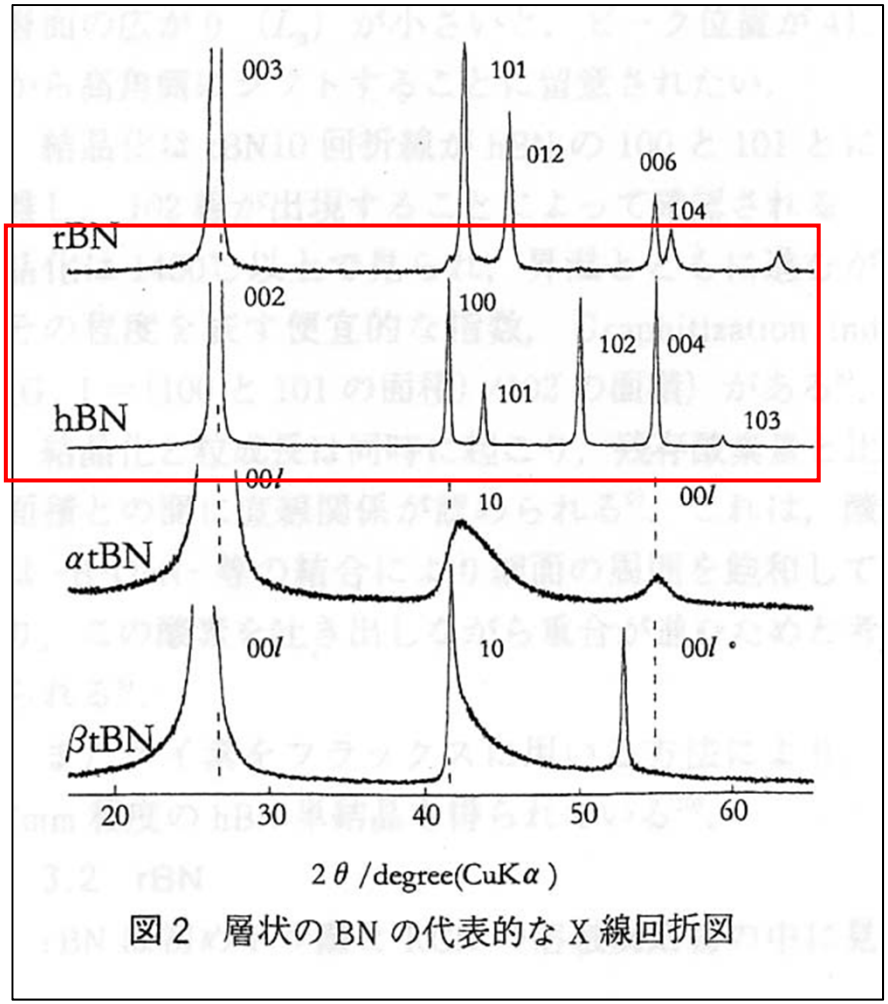


図２　層状の BN の代表的な X 線回折図

佐藤忠夫、セラミックス 37 (2002) No4 p.272

Denka

Properties of Ceramic Materials

			BN	Al_2O_3	Si_3N_4	AlN	SiC
Thermal Properties	Thermal Conductivity	W/mK	40～80	26	33	100～200	65～100
	Thermal Expansion	10^{-6}/K	2.8	7.1	3.0	4.5	4.0
Electrical Properties	Resistance	Ω･cm	$>10^{14}$	$>10^{14}$	$>10^{14}$	$>10^{14}$	10^{-1}
	Dielectric Constant	—	4.5	9.8	8.6	8.4	—
Specific Gravity		g/cm^3	2.3	4.0	3.2	3.3	3.4

BN is a light material with excellent thermal and electrical properties.

Denka

Applications of BN powder

1. Mold release for glass
2. Release powder, paving powder, packing powder for producing sintered ceramics（AlN、Si3N4）
3. Lubricating grease (solid lubricant)

3 Big Applications

4. Thermal conductive filler(silicone & epoxy resin)
5. Insulated filler(fluorine resin)
6. Sintered BN(shapes)
7. Additives for crystallization of resin(POM, PPS, PA)

Maximum operating temperature

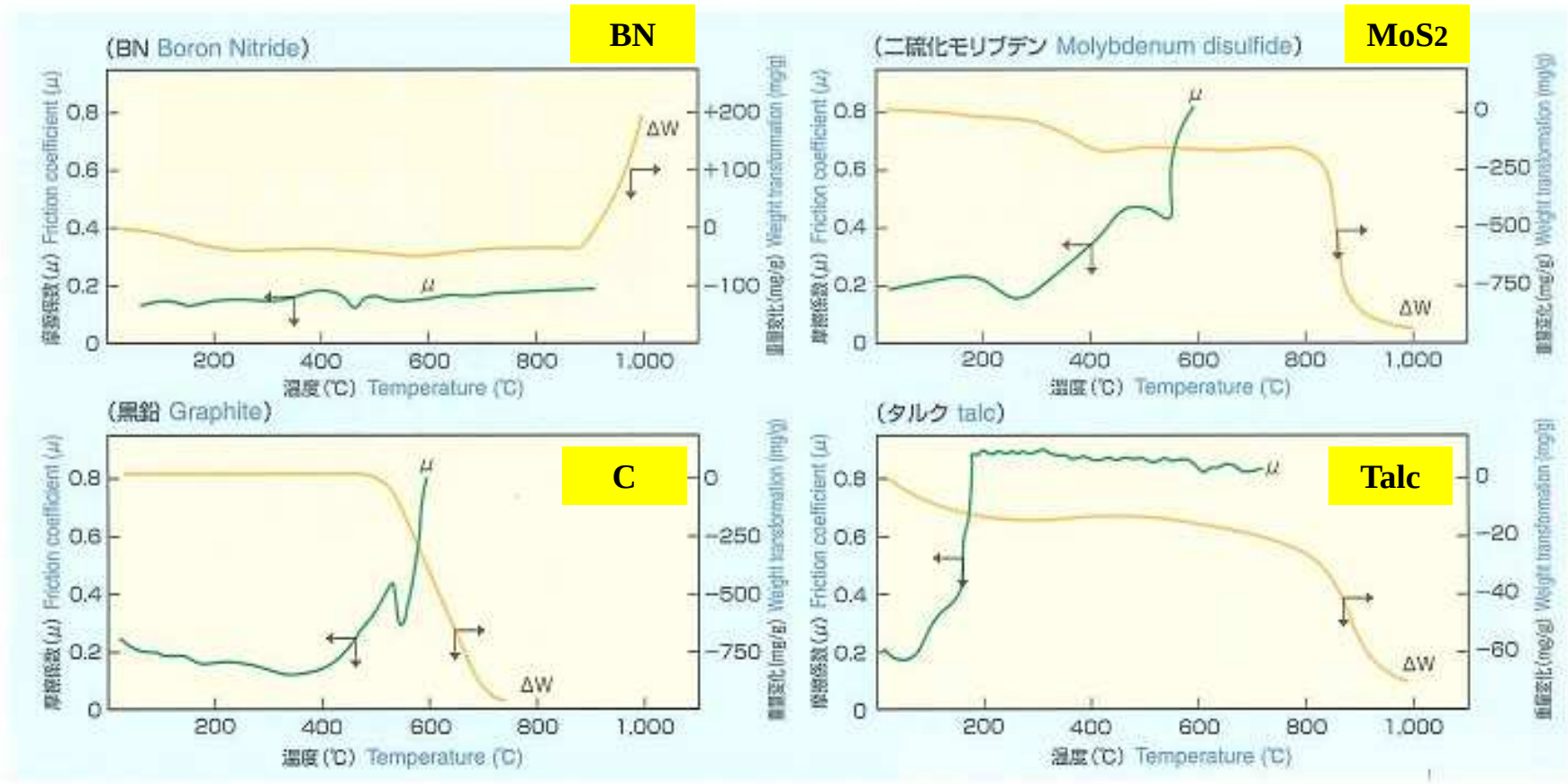
In the air : around 900℃

In inert atmosphere/Under vacuum : around 2000℃

Denka

Coefficient of friction for various lubricants

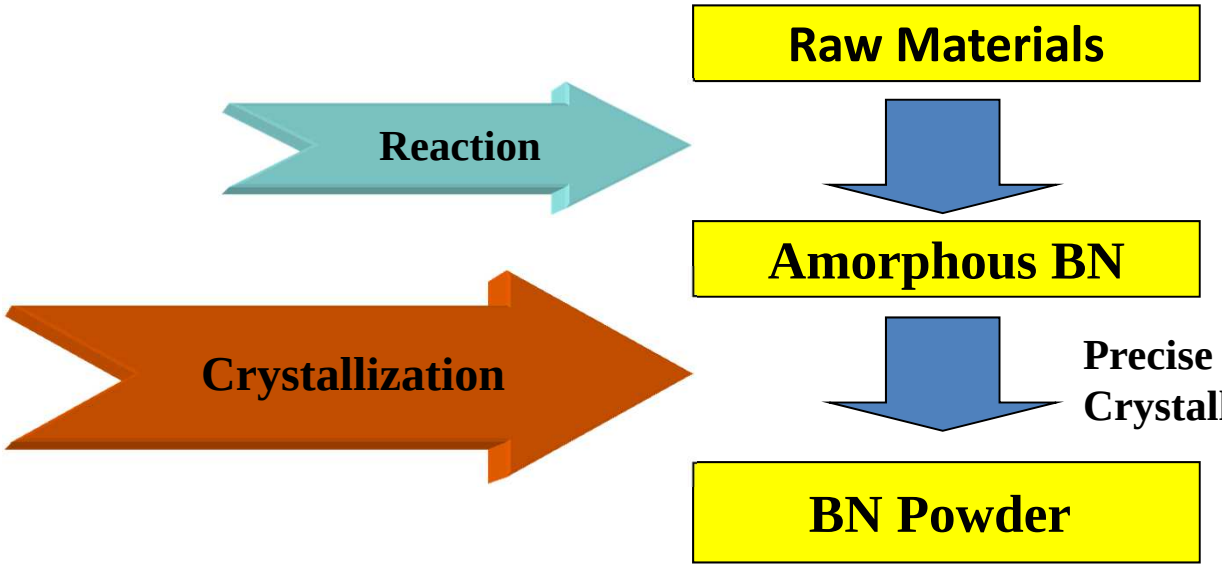
●Coefficient of friction for various lubricants, temperature dependence for feat weight transformation.



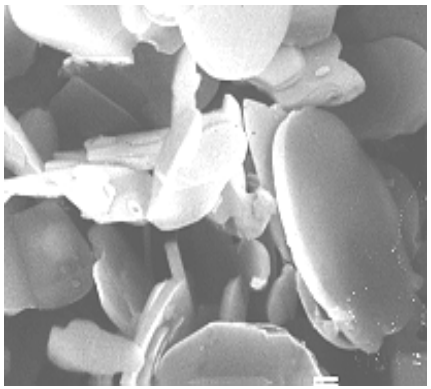
Friction coefficient of BN is stable till 900℃.

Denka

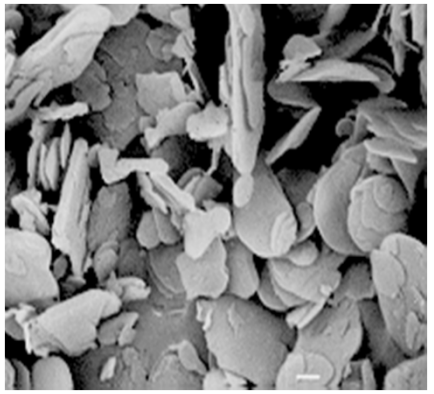
Manufacturing process of DENKA BORON NITRIDE POWDER



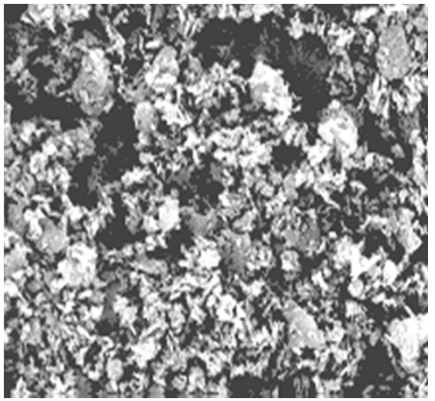
SGPS — 10 μm



SGP — 10 μm



GP — 10 μm

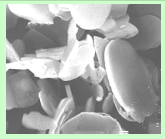
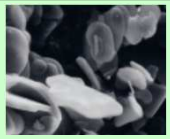
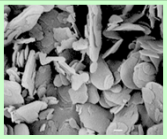
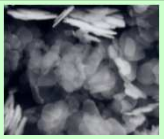
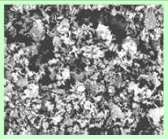
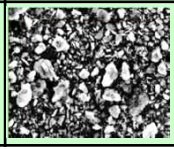
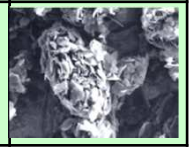


SP-2 — 10 μm

Denka

DENKA BORON NITRIDE POWDER Grade List

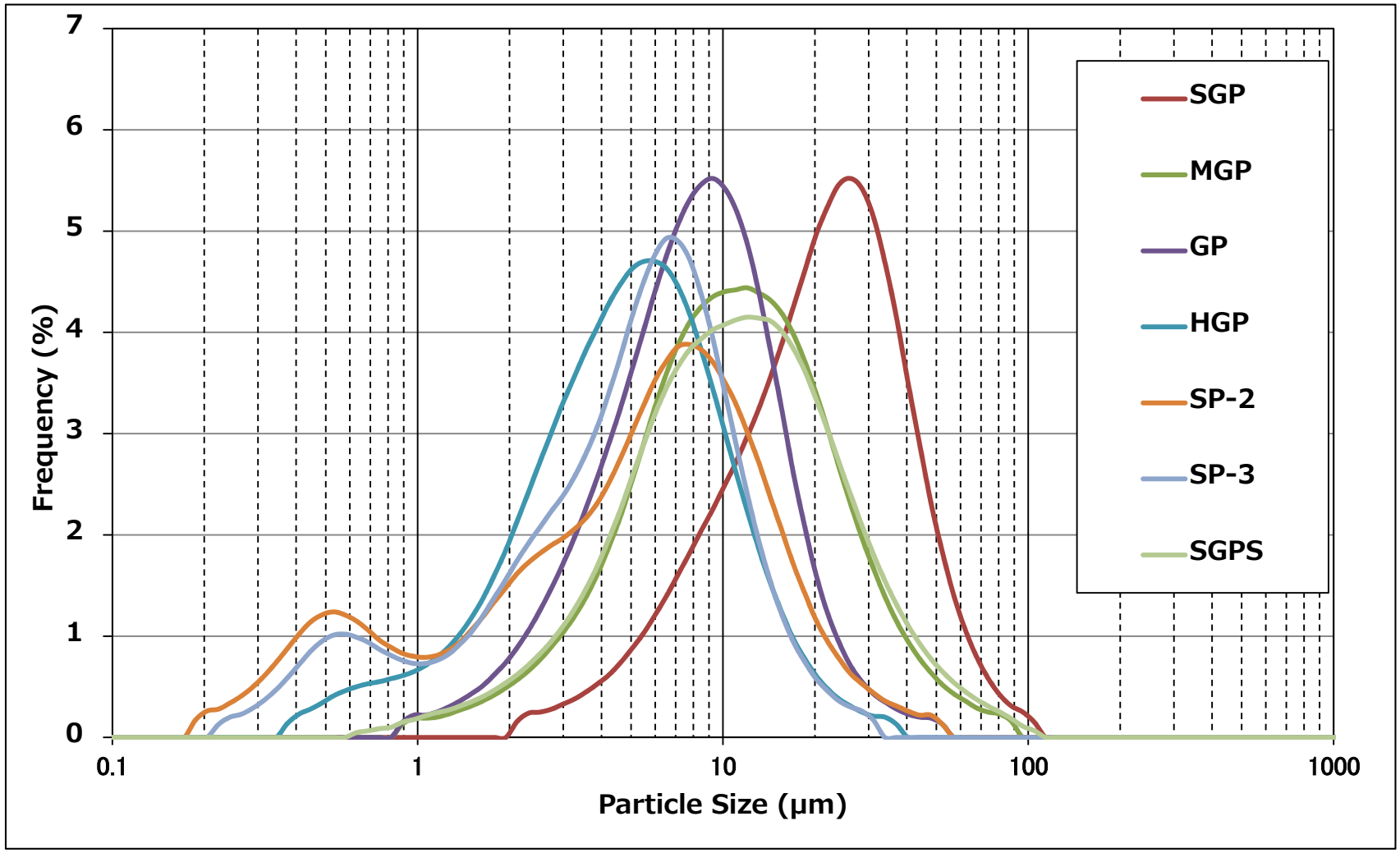
(representative data)

Properties \ Grade			Platelet						Aggregate
			SGP	MGP	GP	HGP	SP-2	SP-3	SGPS
Composition	BN	%	99	99	99	99	97	98	86
	B2O3	%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	T-O	%	0.3	0.4	0.5	1.0	1.8	0.9	7.0
	T-C	%	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1
Properties	SSA	m^2/g	2	3	6	9	34	25	2
	D50	μm	18	10	7	5	4	4	12
	Density	g/cm^3	0.8	0.8	0.5	0.4	0.4	0.4	0.5
	G.I.		0.9	0.9	0.9	1.2	7.5	4.0	1.5
SEM image (10μm)									

T-O : Total Oxygen T-C : Total Carbon SSA : Specific Surface Area
D50 : Average Particle Size by Laser Diffraction and Scattering (Microtrack) method, after distributed processing by the supersonic wave.
Density : Tapping Density

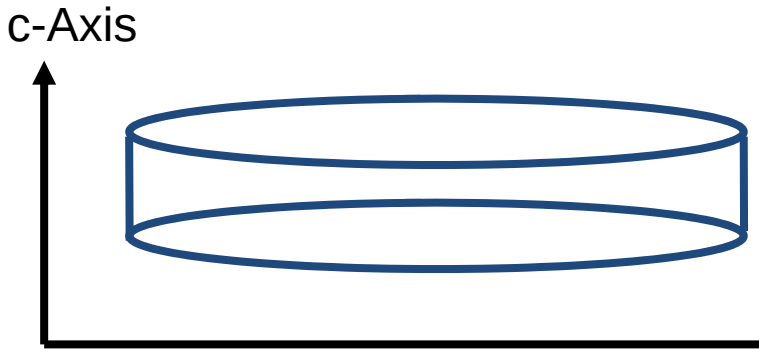
Denka

Particle Size Distribution



Denka

Anisotropy of BN powder



c-Axis TC << a-Axis TC

About 1／20

TC=80W/mK

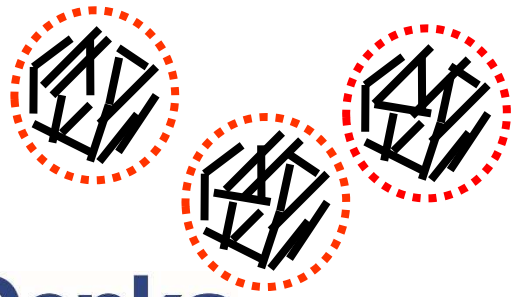
※TC :Thermal Conductivity

◇Problem caused by the shape of BN powder

Lower thermal conductivity due to the orientation of powder

Higher viscosity – Lower filler contents

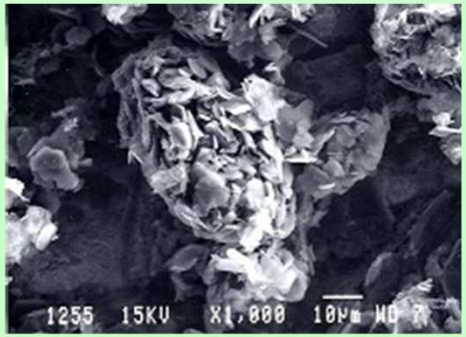
Cancellation of Orientation anisotropy by Aggregated Particle Formation

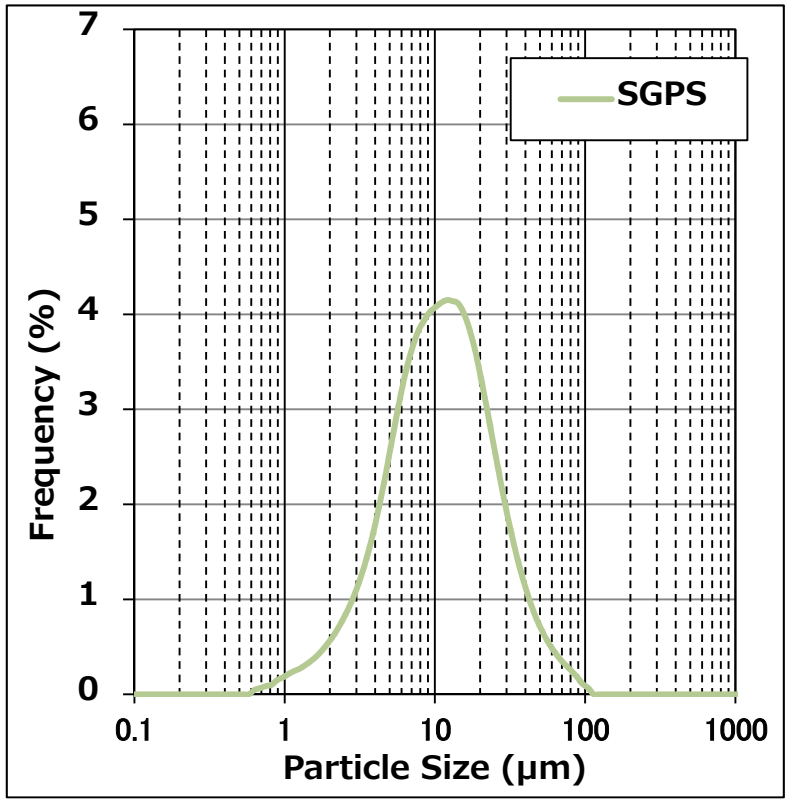


Need for the development of aggregated grade

Denka

Aggregated Grade: SGPS

ITEM \ GRADE		SGPS
SEM Image		
Average Particle Size	(μm)	12
Specific Surface Area	(m^2/g)	2
Tap Density	(g/cm^3)	0.5
Crystallity/GI value		1.5
BN	(%)	86
B2O3	(%)	0.1
O	(%)	7.0
C	(%)	<0.1



Average Particle Size : by Laser Diffraction and Scattering (Microtrack) method, after distributed processing by the supersonic wave.

Specific Surface Area : by BET method

Denka

Appropriate usage for Each Grade

	Standard				Fine		Agglomerated
	SGP	MGP	GP	HGP	SP-3	SP-2	SGPS
Thermal Conductive Filler	○	○			○※		○
Remover and Bed Powder			○	○			
Lubricant Filler			○	○	○	○	
Tribology			○				
Sintering Powder	○				○	○	
Additives (Engine Oil etc.)							
Additives for Crystallization Nuclei for Resin					○	○	

※ Suitable for a thin film

Denka