General Introduction

Fine particles for a fine future.

TODA

TODA KOGYO CORP.

FEROTOP™

(Magnetic compounds for bonded magnet)

Table of contents

What is FEROTOP™?

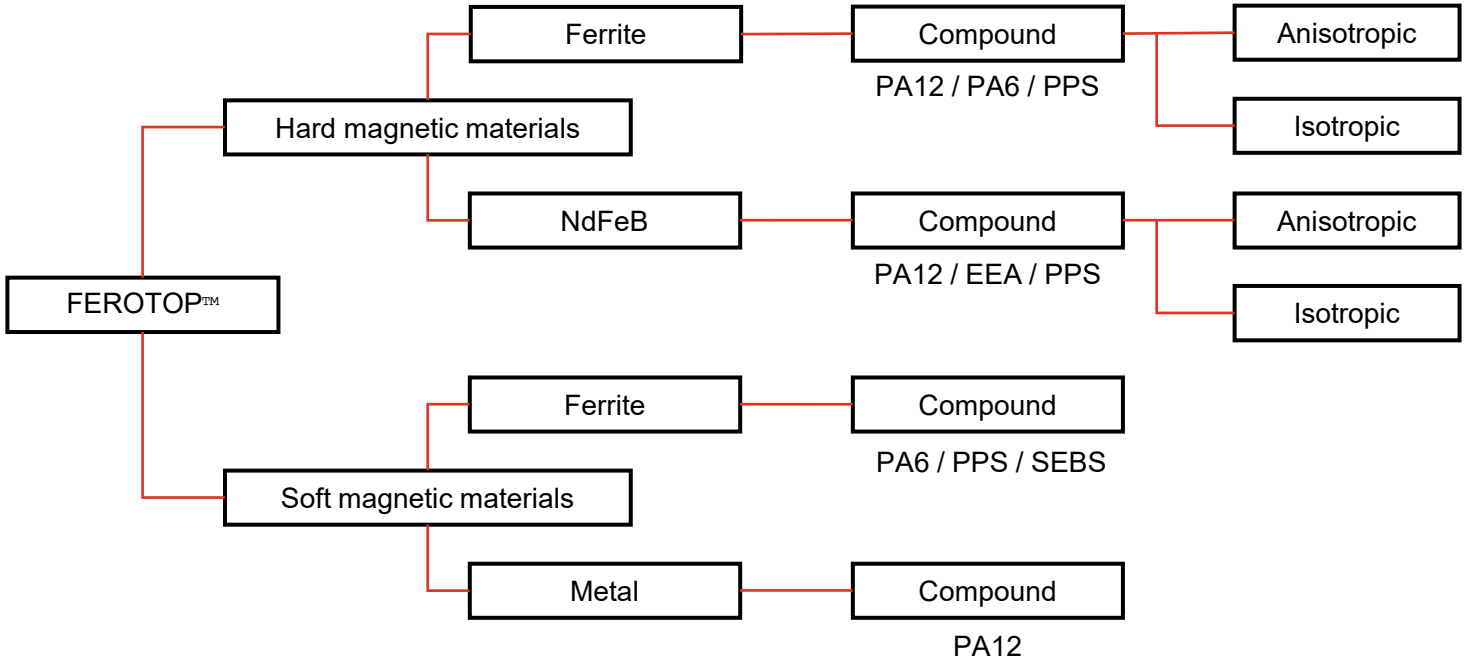
"FEROTOP™" means TODA KOGYO's bonded magnet compounds for molding purpose that are composite of resins and magnetic powders.
We have a wide variety of products portfolio regarding both hard and soft magnetic compounds as shown below, which has been adopted in various applications in various industries.
Based on the knowledge accumulated on "FEROTOP™" for many years, we can customize the characteristic of magnetic compounds to meet the wide range of requests from customers.

"FEROTOP™" has the following features.

- **Excellent processability, possible to mold into various sizes and complicated shapes with high dimensional accuracy.**
- **Flexible magnetic designs of waveforms by various ways of magnetization, including radial orientation and multi-pole magnetization (for hard magnetic materials).**
- **Integrated and simplified process achievable, by molding compounds and other parts at once.**

Not only customizing the compounds' characteristics, but we can also design the compounds from its raw materials to meet customer's required specification, as we develop and manufacture magnetic powders by our own. Moreover, we have compound production bases located not only in Japan but also in China and Thailand so we can respond to the global demand from our customers.

FEROTOP™ lineup



Features / Applications

Features

◆**Excellent processability**
- Possible to mold into various sizes and complicated shapes with high dimensional accuracy
- Excellent strength and impact resistance

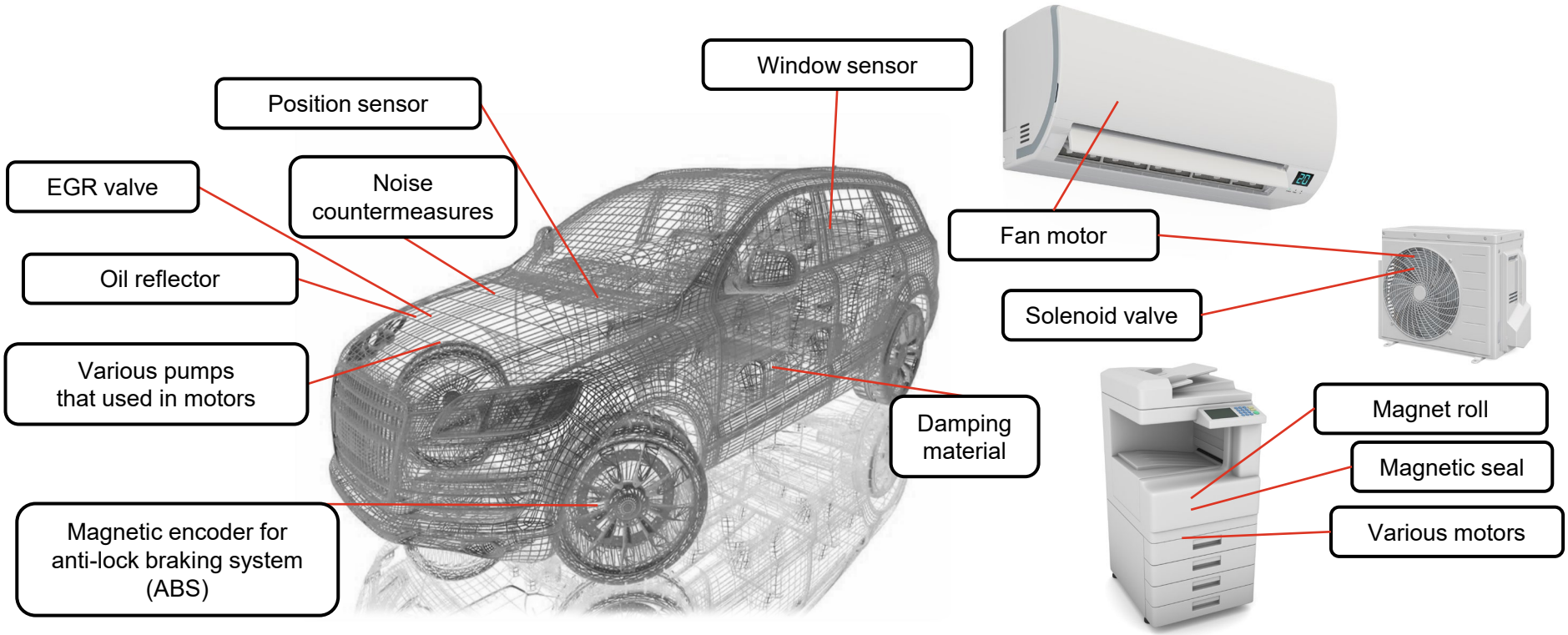
◆ **Flexibility to magnetization (hard magnetic material)**
- Easy to adapt to multi-pole magnetizing such as radial orientation and complex magnetizing

◆**Cost efficiency by integral molding**
- Integrated and simplified process achievable, by molding compounds and other parts at once.
- Possible to make anisotropic magnets with magnetic field orientation mold or magnetic field injection molding machine.

Item	Injection	compression	Sintered
Strength	◎	△	×
Weather-resistance	○	*△	*×
Magnetic force	△	○	◎
Accuracy of dimension	◎	△	△
Flexibility of design	◎	×	×
Integral molding	◎	×	×

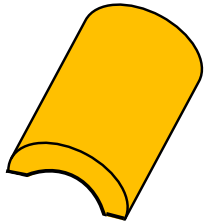
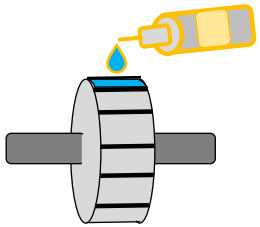
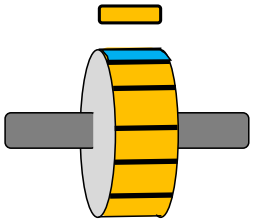
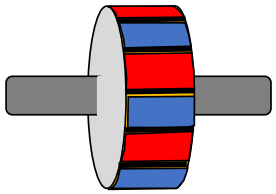
*Compression and sintered may require coating such as plating.

Applications



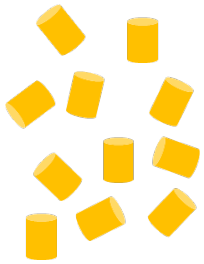
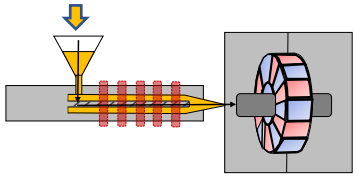
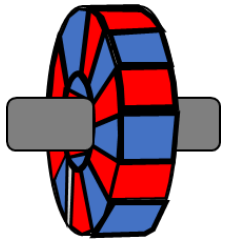
Advantage of using FEROTOP™ - Integrated molding -

◆ Process when using sintered magnets

Purchase of magnets	Applying of adhesive	Sticking magnets	Other processes	Rotor
			Thermosetting ↓ Magnetization	
Difficult to arrange the shape of magnets for intended application by your own.	Adhesion ➔ The pasting process is required, which increases both production costs and labor costs.		Heating and magnetizing processes are required.	

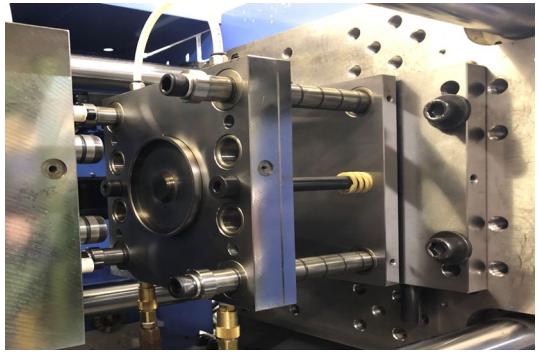
Process simplification

◆ Process when using plastic magnets

Purchase of materials	Injection molding in a magnetic field	Other processes	Rotor
	**Charge Materials** 	Magnetization	
Possible to arrange the shape of magnets as intended by injection molding.	Possible to mold the magnetic materials directly to core shafts without using adhesive.(Orientation is required for anisotropic materials)	Magnetization process is required.(depending on the material)	

Solutions provided by TODA KOGYO Group

Injection molding machine



Magnetic powders

Powders

- Hard ferrite powders
- Soft ferrite powders
- NdFeB powders
- Metal powders

✓ Material development
✓ Control powder properties

Partnership

- Optimized supply chain of group affiliates
- Proposal of total solutions for “the ultimate issues to solve"

Solution proposals from powder supply to application

Compounds

Composite with resin

- For injection (PA, PPS, EEA)
- For extrusion (EEA, SEBS)

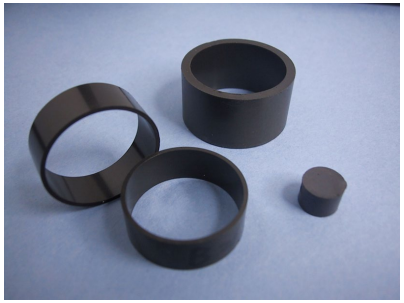
✓ Powder optimization
✓ Surface treatment technology

Solution

- Analysis of magnetic field
- Support of magnet molding
- Support of prototype mold design

✓ Analysis technology
✓ Injection molding technology
✓ Mold design technology

Molded products



Magnetic compounds

Production bases

We have magnetic powders / compounds manufacturing facilities in Japan and various location overseas.
We can provide products from the nearest location of customer in order to meet the needs from the view of Business Continuity Plan (BCP), transportation efficiency and others.

			①	②	③	④	⑤	⑥
Manufacturing location			TODA KOGYO CORP. Otake Plant	Toda Magnetic Material (Tianjin) Co., Ltd.	Toda Plastic Material (Zhejiang) Co., Ltd.	Zhejiang East Magnetic Industry Co., Ltd.	TODA KOGYO Asia (Thailand) CO., LTD	Jiangmen & Partner's Magnetic Product Co., Ltd.
Area			Japan(Hiroshima)	China(Tianjin)	China(Zhejiang)	China(Zhejiang)	Thailand(Ayutthaya)	China(Guangdong)
Production item	Ferrite	Powder	○	-	-	○	-	-
		Compound	○	-	○	-	○	-
		Molded component	-	-	-	-	-	○
	NdFeB	Powder※	○	○	-	-	-	-
		Compound	○	○	-	-	-	-
		Molded component	-	-	-	-	-	○
ISO certification obtained in:		ISO9001	1998	2010	2005	2008	2017	2009
		ISO14001	2002	2012	2006	2013	2018	2009
		IATF16949	2023	-	2022	-	-	2017

※ Regarding NdFeB powders, we manufacture only anisotropic ones.
(Soft ferrite powder and compound are produced only at Otake Plant.)

Hard ferrite compound (Property overview)

Manufacturing location: **Hiroshima (Otake)**

Resin	Property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold density (g/㎤)	Melt flow (g/10min)	Melt flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA12	Low magnetic	PE-501*	100	73	176	1.8	2.84	223	270℃/10kg	98	55	N.B.	9.7
		PE-201	207	158	252	8.4	2.96	193	270℃/10kg	94	53	N.B.	-
	High magnetic	TP-A25N	275	183	237	14.8	3.55	45	270℃/10kg	128	62	22	-
	Shock resistant	TP-A26FS	283	189	235	16.0	3.64	22	270℃/10kg	93	46	24	6.6
	High magnetic / High strength	TP-A27E	288	189	233	16.2	3.69	59	270℃/10kg	96	46	22	6.1
	High magnetic / High coercive force	TP-W27MB (In Lab.)	287	205	259	16.5	3.72	96	270℃/10kg	102	57	15	-
	High magnetic / High melt flow	TP-A27N	293	187	222	16.9	3.75	99	270℃/10kg	108	60	12	6.0
	High magnetic	TP-A27P	302	190	226	18.0	3.83	64	270℃/10kg	93	62	9	5.2
		TP-A28NK (In Lab.)	306	197	238	18.7	3.80	96	270℃/10kg	112	56	18	-
		TP-Z29 (In Lab.)	323	200	228	20.7	3.95	101	270℃/10kg	90	51	7	-

Hard ferrite compound (Property overview)

Manufacturing location: **Hiroshima (Otake)**

Resin	Property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold density (g/㎤)	Melt flow (g/10min)	Melt flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA6	High coercivity / High Br	TPA-140	241	182	271	11.5	3.26	36	270℃/5kg	191	101	N.B.	
	High melt flow	TP-F63P	245	178	239	11.8	3.34	167	270℃/10kg	166	91	17	4.0
		TP-F65N	275	185	228	15.0	3.57	138	270℃/10kg	142	75	13	4.9
	High Br / High melt flow	TP-S68	293	186	225	16.9	3.77	108	270℃/10kg	162	93	13	3.7
PPS	Low Br	TP-S73	246	173	234	11.9	3.42	145	330℃/10kg	104	63	8	2.2
	Medium Br	TP-S75	264	178	228	13.7	3.57	207	330℃/10kg	106	60	7	3.3
	High strength	TP-A75C (In Lab.)	258	173	211	13.1	3.56	116	330℃/10kg	121	77	10	-
	High melt flow	TP-S76	270	183	232	14.2	3.65	160	330℃/10kg	105	57	7	3.2

Hard ferrite compound (Property overview)

Manufacturing location: **China (Zhejiang)**

Resin	Property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold density (g/㎤)	Melt flow (g/10min)	Melt flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA12	High strength	TP-F26S	282	188	228	15.6	3.63	65	270℃/10kg	115	59	16	-
		TP-A27E(P2A)	288	191	239	16.4	3.65	60	270℃/10kg	111	51	21	-
	High Br / High strength	TPA-202	293	192	231	17.0	3.68	60	270℃/10kg	113	58	18	-
		TP-A27ES	290	192	230	16.5	3.68	40	270℃/10kg	104	54	20	-
		TP-A27C	290	196	236	16.6	3.65	53	270℃/10kg	108	52	24	-
		TP-A27E	289	190	229	16.4	3.69	65	270℃/10kg	92	46	20	6.1
		TP-A27E(T)	294	191	231	17.0	3.70	58	270℃/10kg	105	50	22	-
	High Br / High melt flow	TP-A27NK	298	193	228	17.4	3.73	94	270℃/10kg	99	55	12	-
PA6	High Br / High melt flow	TP-S62	239	170	231	11.1	3.27	100	270℃/10kg	189	100	N.B.	-
		TP-S65	275	187	221	14.9	3.63	135	270℃/10kg	167	79	12	-
	High Br / High strength	TP-S67K	290	180	211	16.5	3.73	70	270℃/10kg	182	98	14	-
	High Br / High melt flow	TP-S68	292	185	215	16.9	3.77	85	270℃/10kg	163	90	10	3.7
	High Br	TP-S69	308	183	207	18.7	3.87	75	270℃/10kg	177	90	12	-
	High Br / High strength	TP-S68C	294	179	209	17.0	3.77	77	270℃/10kg	171	96	15	-
PPS	Medium Br	TP-S75	259	181	228	13.2	3.56	230	330℃/10kg	95	60	7	3.3

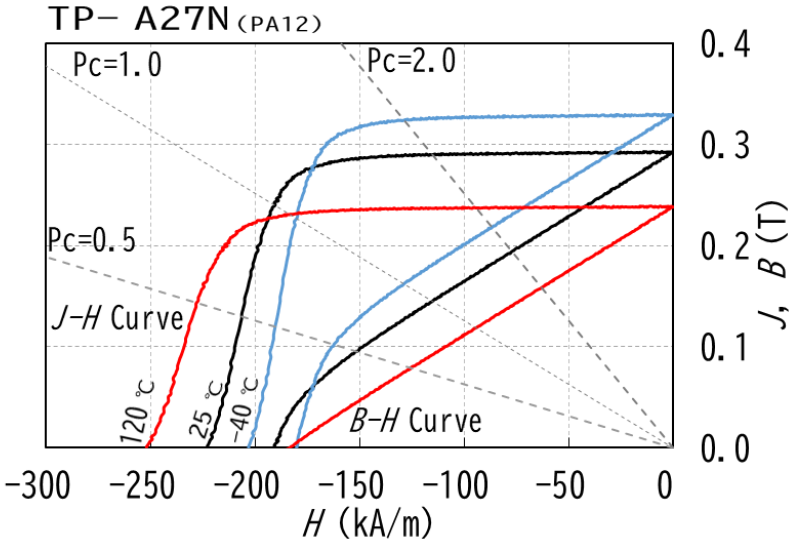
Hard ferrite compound (Property overview)

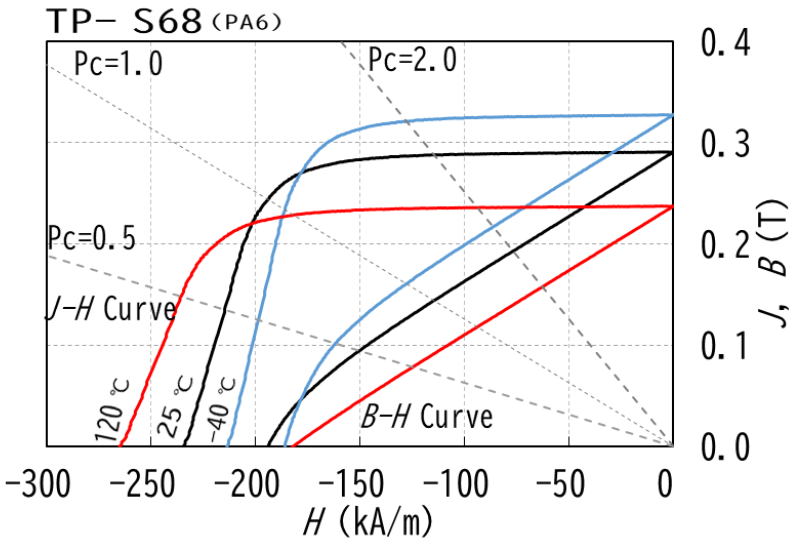
Manufacturing location: **Thailand (Ayutthaya)**

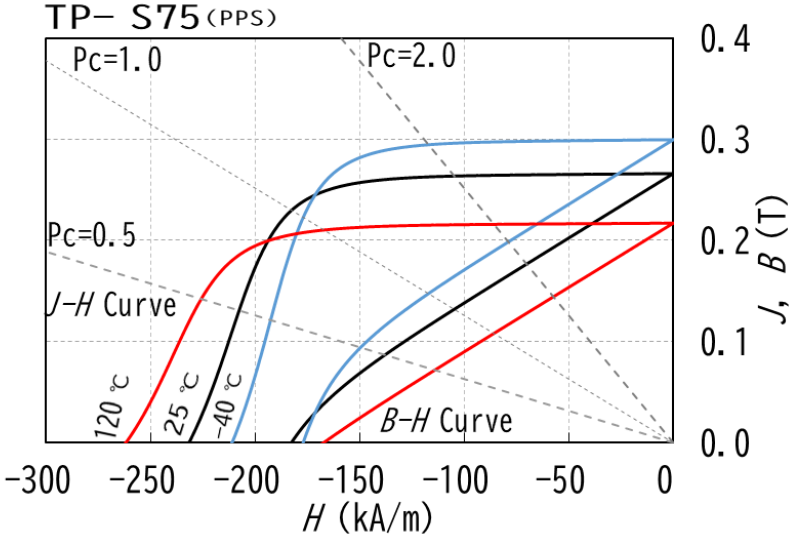
Resin	Property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold density (g/㎤)	Melt flow (g/10min)	Melt flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA12	High strength	TP-A27E (P2A)ND	281	188	235	15.4	3.65	71	270℃/10kg	108	50	20	-
	High coercivity	TP-W27N	286	200	252	15.9	3.74	83	270℃/10kg	105	51	18	-
	High Br / High melt flow	TP-A27N	289	186	224	16.2	3.74	90	270℃/10kg	98	53	11	6.0
PA6	High Br / High melt flow	TP-S68	289	189	228	16.2	3.77	92	270℃/10kg	160	86	15	3.7
	High strength	TP-S68NT	286	191	230	16.0	3.76	60	270℃/10kg	166	98	14	-

The demagnetization curves at -40°C and 120 °C are calculated ones which are based on the actual demagnetization curve at 25 °C and following temperature coefficients.

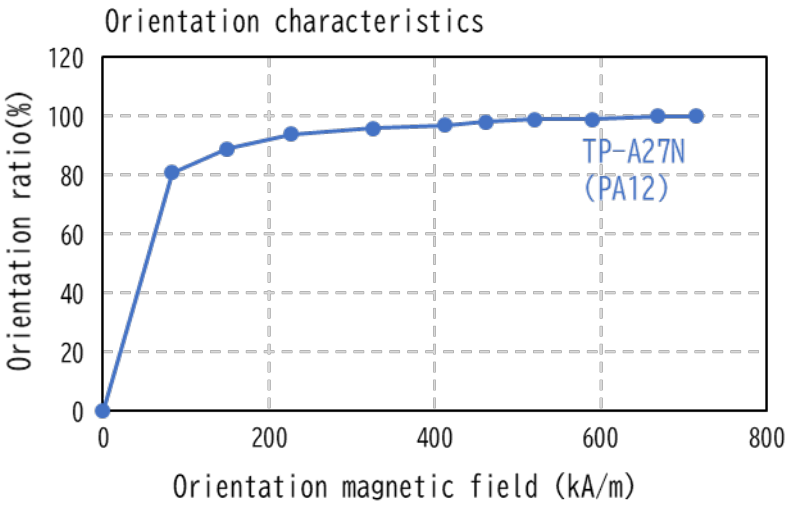
Temp. (℃)	-40	120
α_{Br} (%/℃)	-0.19	-0.19
β_{Hcj} (%/℃)	0.14	0.14

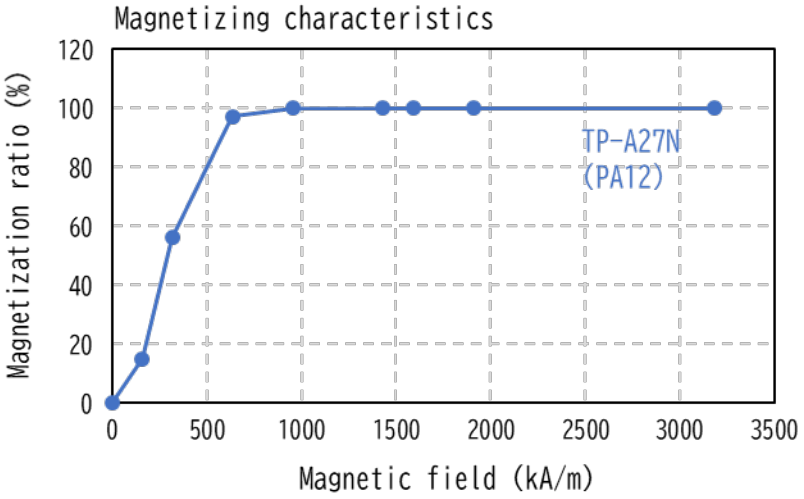






Hard ferrite compound (Orientation / Magnetizing characteristics)





◆ Orientation characteristics

- This is the result of measurement after orientation without magnetization.
- The orientation ratio of the anisotropic compound is calculated in comparison to the value at 700 kA/m as 100%.

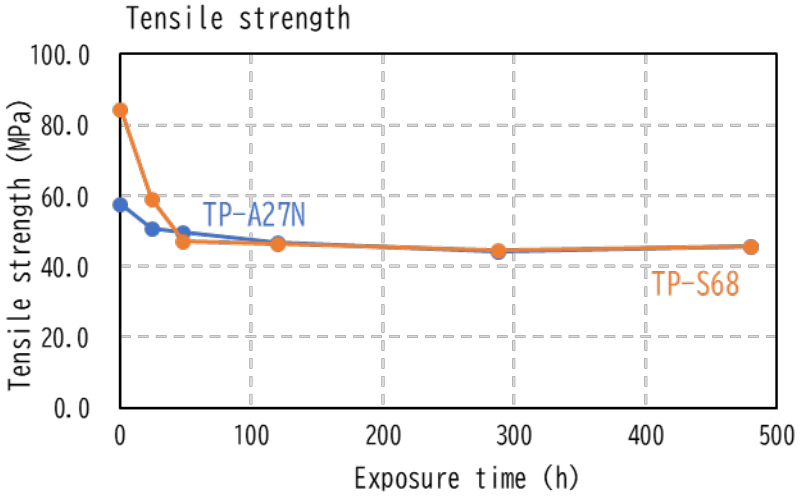
◆ Magnetizing characteristics

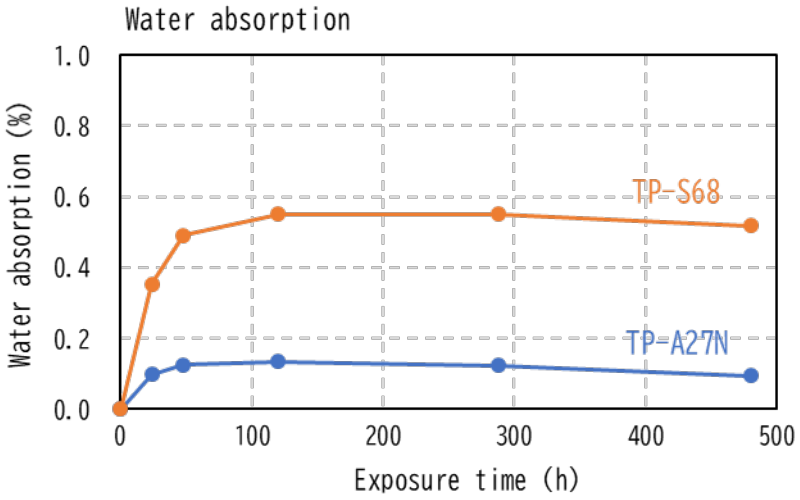
- This is the result of measurement after the processing of (i) orientation at 700 kA/m, (ii) demagnetization, and (iii) magnetization.
- The magnetization ratio is calculated in comparison to the value magnetized at 3200 kA/m as 100%.

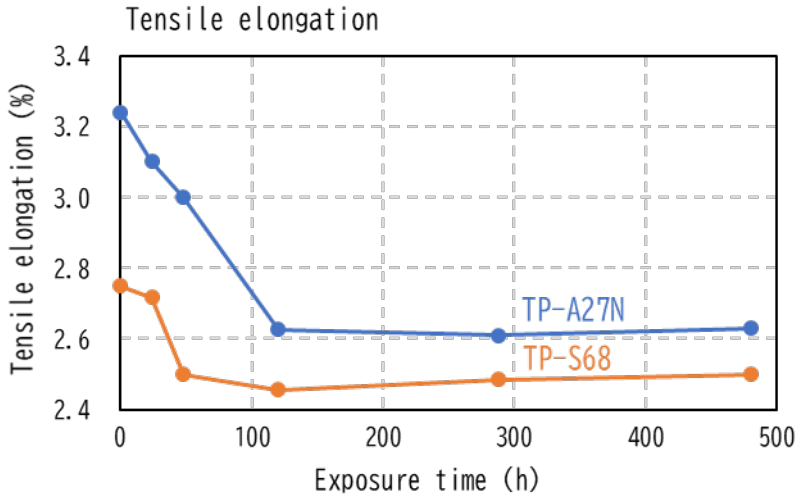
Hard ferrite compound (Water absorption rate and strength change)

- Tensile strength and tensile elongation are the results measured at room temperature after the specified exposure time.
- The water absorption rate is the result calculated from the weight change of the dumbbell test piece before and after the specified exposure time.

- Test grade: TP-A27N (PA12), TP-S68 (PA6)
- Sample shape: Dumbbell test piece 175 x 12.5 x 3.2mm
- Exposure environment: 85 °C / 85% RH





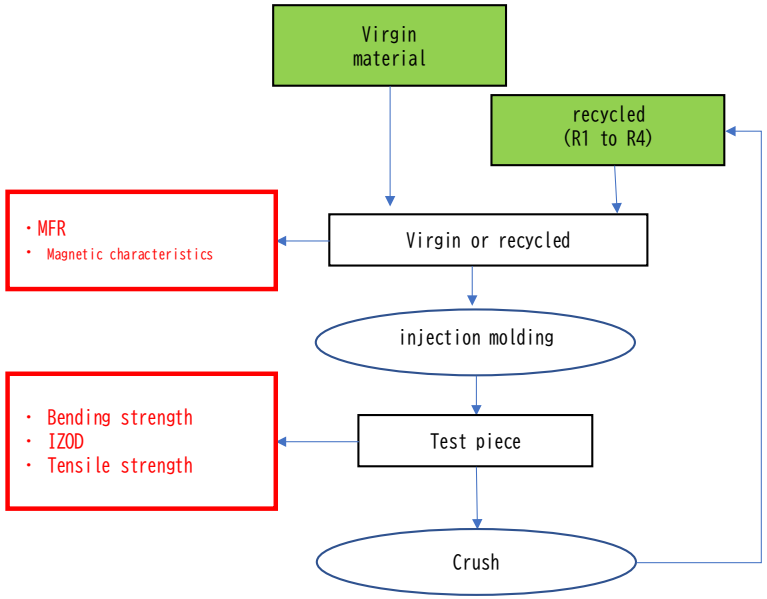


* The values shown are values of central tendency.

Hard ferrite compound (Recyclable rate ①)

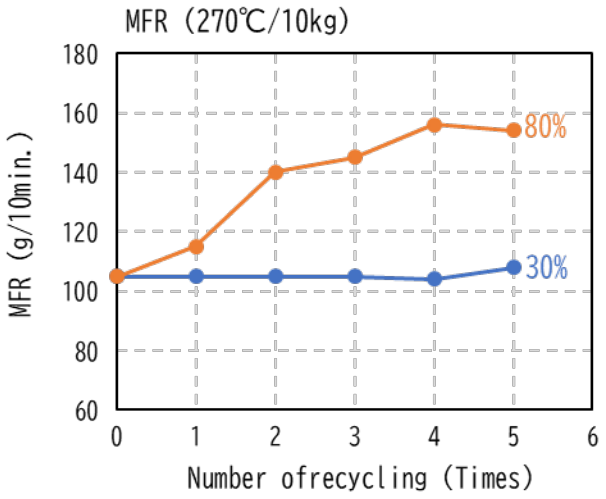
Test grade：TP-A27N (PA12)

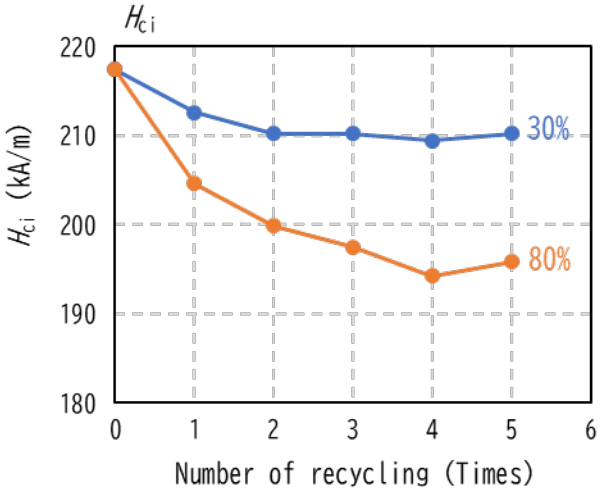
Recycling flow

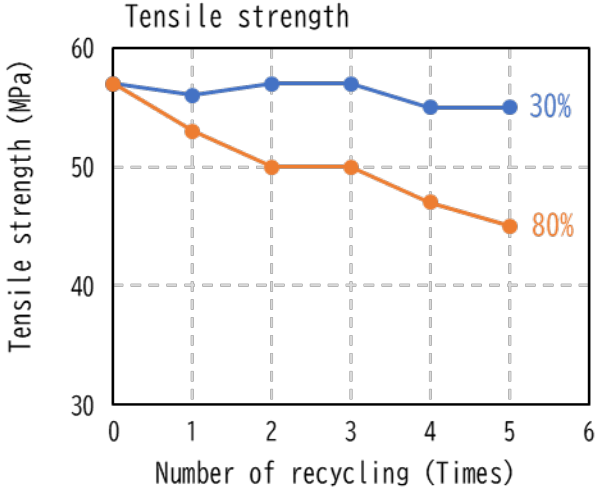


Recycling rate (%)	No.	B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/m³)	MFR (g/10min)	Bending strength (MPa)	Tensile strength (MPa))	IZOD strength (kJ/m²)
30	V	289	187	217	16.7	105	113	57	16
	R1	290	185	212	16.7	105	113	56	14
	R2	290	183	210	16.7	105	112	57	13
	R3	290	183	210	16.7	105	112	57	13
	R4	288	181	209	16.6	104	110	55	13
80	V	289	187	217	16.7	105	113	57	16
	R1	288	177	205	16.6	115	105	53	11
	R2	291	177	200	16.8	140	102	50	11
	R3	290	174	197	16.6	145	99	50	10
	R4	289	171	194	16.7	156	99	47	10

* MFR measurement conditions: 270 ℃ / 10kg



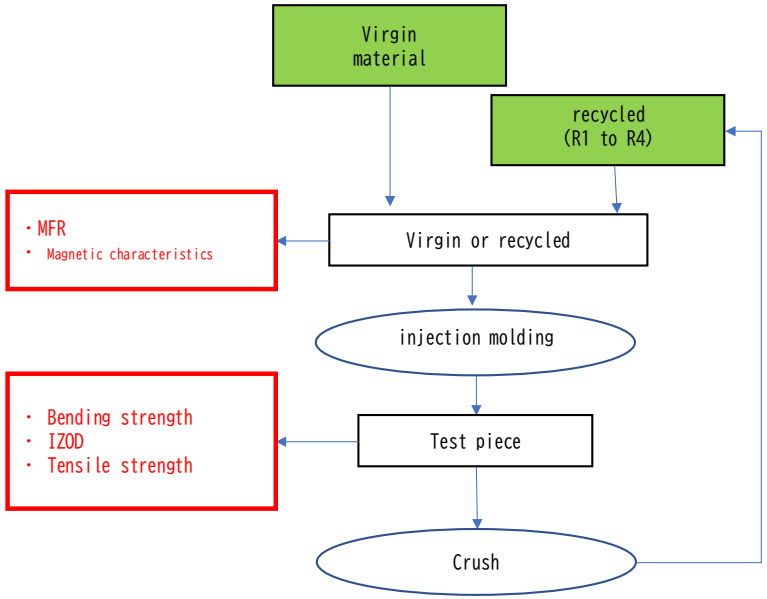




Hard ferrite compound (Recyclable rate ②)

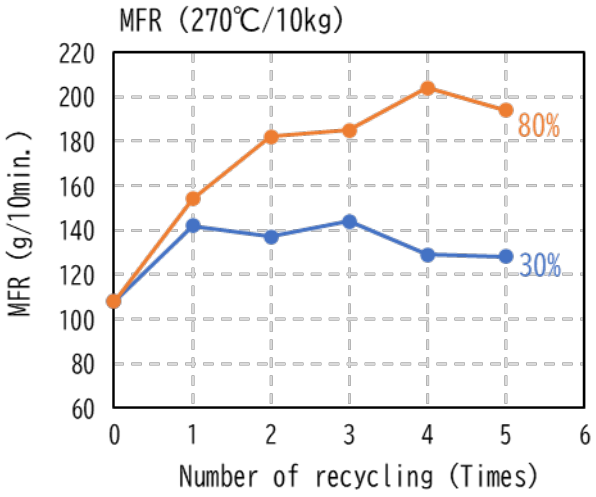
Test grade：TP-S68 (PA6)

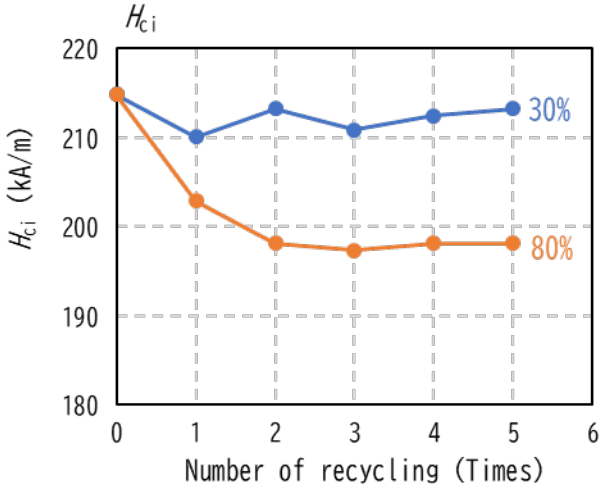
Recycling flow

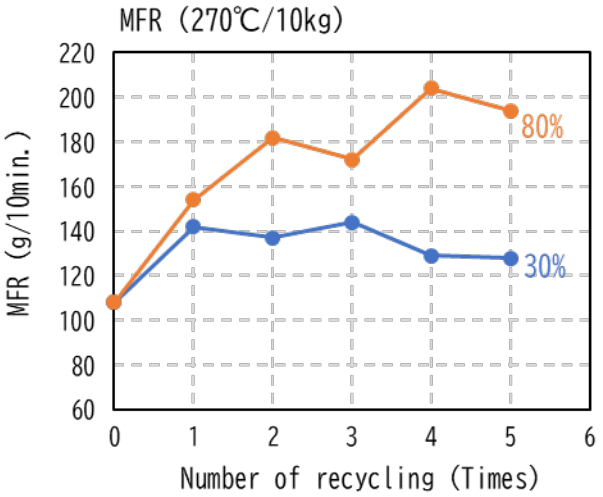


Recycling rate (%)	No.	B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/m³)	MFR (g/10min)	Bending strength (MPa)	Tensile strength (MPa))	IZOD strength (kJ/m²)
30	V	289	181	215	16.4	108	162	88	14
	R1	292	180	210	16.8	142	153	86	11
	R2	289	181	213	16.4	137	143	83	11
	R3	291	180	211	16.7	144	156	80	12
	R4	290	180	212	16.6	129	153	80	11
80	V	289	181	215	16.4	108	162	88	14
	R1	289	173	203	16.5	154	135	76	12
	R2	290	169	198	16.5	182	137	69	10
	R3	291	169	197	16.6	185	133	67	11
	R4	292	170	198	16.7	204	133	64	9

* MFR measurement conditions : 270℃/10kg







Isotropic

Resin	Property	Grade	Magnetic property ASTM-A977 B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/m³)	Physical property ASTM-D792 Mold density (g/cm³)	ASTM-D1238 Melt flow (g/10min)	Melt flow Temp./Load	ASTM-D790 Flexural strength (MPa)	ASTM-D638 Tensile strength (MPa)	ASTM-D256 IZOD impact strength (kJ/m²)	JIS K 7197 Linear expansion coefficient (×10-5/℃)
PA12	General	TRP-L230	390	279	736	27.1	4.05	680	270℃/5kg	105	60	23	6.8
		TRP-L240	460	322	724	36.6	4.60	440	270℃/5kg	116	64	22	6.0
		TRP-L250	507	338	693	43.0	5.01	470	270℃/5kg	122	60	17	3.8
		TRP-L260	556	362	717	50.1	5.37	480	270℃/5kg	101	54	10	3.2
	High thermal stability	TRP-M260	531	368	954	48.5	5.11	520	270℃/5kg	104	60	15	4.3
	High Br	TRP-N270	585	370	710	54.1	5.28	510	270℃/5kg	107	60	13	2.8
		TRP-N280S	619	385	704	59.7	5.54	770	270℃/5kg	85	47	8	3.0
		TRP-N280F	614	409	746	62.1	5.53	810	270℃/5kg	104	57	9	2.8
		TRP-N290F	678	440	735	74.0	5.90	350	270℃/5kg	90	56	6	2.2
EEA	High Br	TRP-N970	573	373	789	53.3	5.26	94	200℃/10kg	-	-	-	-
PPS	General	TRP-L740	462	325	742	37.4	4.74	180	310℃/5kg	115	75	9	2.0
		TRP-L750	500	349	727	43.8	5.08	110	310℃/5kg	80	58	6	1.5
	High thermal stability	TRP-M760	525	374	939	49.3	5.30	80	310℃/5kg	68	43	5	1.3
	High Br	TRP-N750B	495	343	739	43.0	4.87	120	310℃/5kg	107	69	11	1.8
		TRP-N760	533	347	689	46.9	5.08	70	310℃/5kg	93	56	8	1.2
		TRP-N770F	596	394	711	58.1	5.44	100	310℃/5kg	64	39	4	-

NdFeB compound (Property overview)

Hybrid (NdFeB + ferrite)

Resin	Property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold Density (g/㎤)	Melt Flow (g/10min)	Melt Flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA12	-	TRP-Y235	338	217	580	19.1	4.39	286	270℃/5kg	106	60	11	-
		TRP-Y240	394	251	643	26.3	4.67	168	270℃/5kg	111	62	13	-
PPS	-	TRP-Y725	353	226	598	20.7	4.52	67	310℃/5kg	114	74	8	-

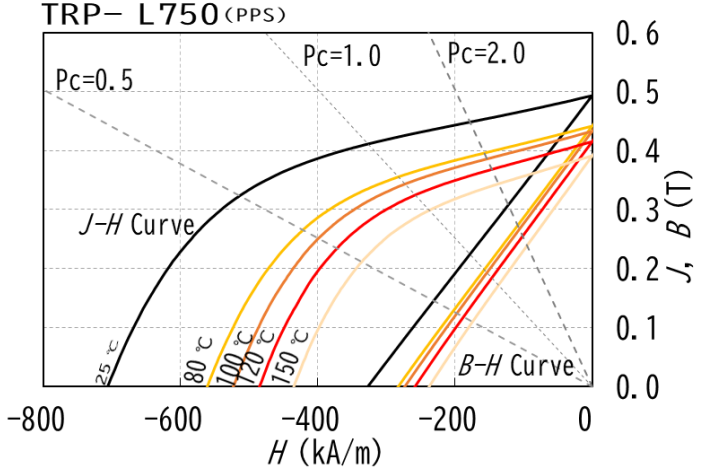
Anisotropic

resin	property	Grade	Magnetic property				Physical property						
			ASTM-A977				ASTM-D792	ASTM-D1238		ASTM-D790	ASTM-D638	ASTM-D256	JIS K 7197
			B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/㎥)	Mold Density (g/㎤)	Melt Flow (g/10min)	Melt Flow Temp./Load	Flexural strength (MPa)	Tensile strength (MPa)	IZOD impact strength (kJ/㎡)	Linear expansion coefficient (×10-5/℃)
PA12	High Br	TRP-A216 (In Lab.)	865	482	965	117	5.55	400	270℃/5kg	95	51	7	-
PPS	High Coercivity	TRP-T710C	685	475	1220	85.1	5.00	110	340℃/10kg	90	55	10	-
	High thermal stability	TRP-T790F (in Lab.)	633	432	1067	69.8	4.94	113	340℃/10kg	99	62	8	-
	High Br	TRP-A712 (In Lab.)	756	423	914	88.3	4.98	184	340℃/10kg	101	59	7	-

*The values of “Anisotropic” are measured in Japan (Otake) .

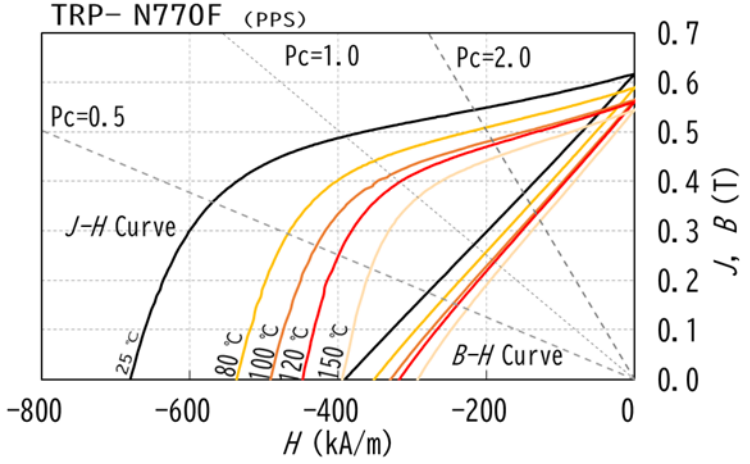
Isotropic NdFeB compound (Temperature property)

TRP– L750 (PPS)



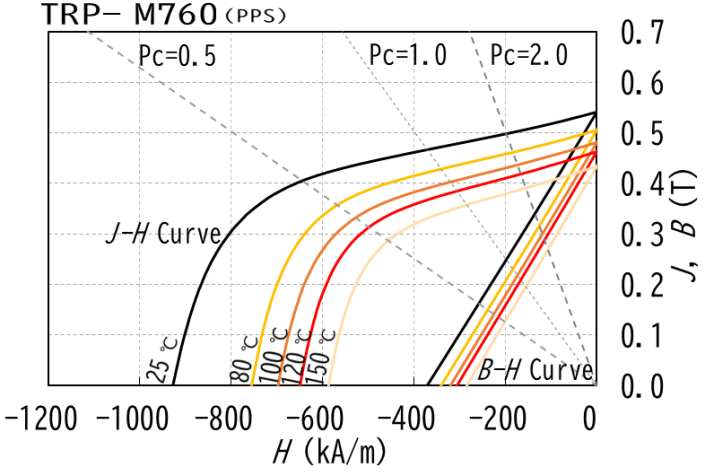
Temp. (℃)	80	100	120	150
α_{Br} (%/℃)	-0.19	-0.16	-0.17	-0.17
β_{Hcj} (%/℃)	-0.37	-0.35	-0.33	-0.31

TRP– N770F (PPS)



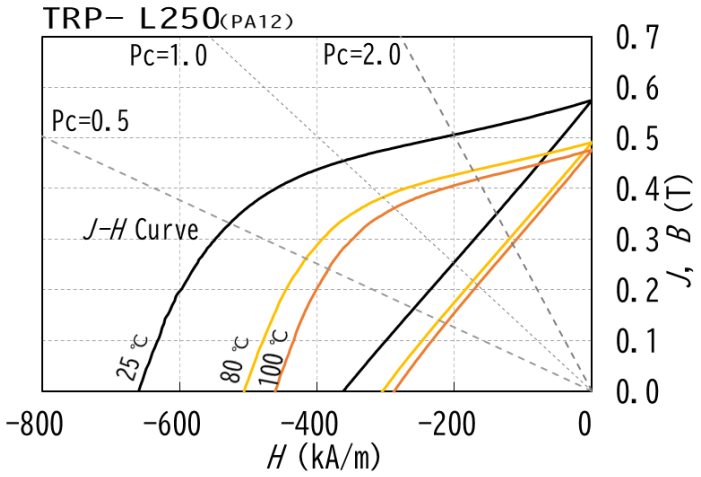
Temp. (℃)	80	100	120	150
α_{Br} (%/℃)	-0.08	-0.11	-0.10	-0.09
β_{Hcj} (%/℃)	-0.38	-0.37	-0.36	-0.34

TRP– M760 (PPS)



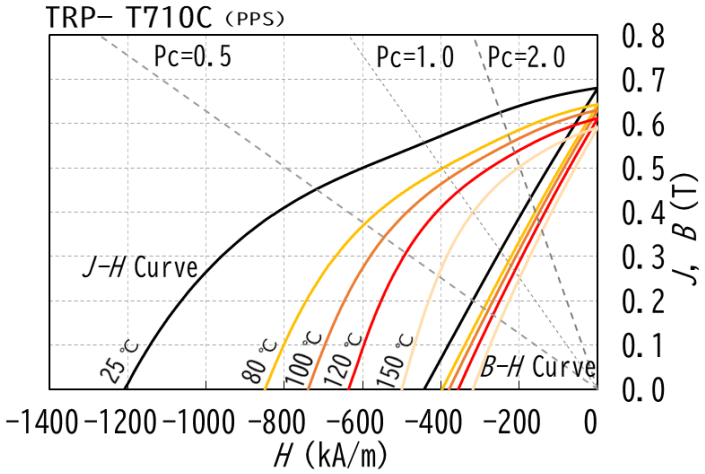
Temp. (℃)	80	100	120	150
α_{Br} (%/℃)	-0.12	-0.15	-0.15	-0.16
β_{Hcj} (%/℃)	-0.34	-0.33	-0.32	-0.29

TRP– L250 (PA12)

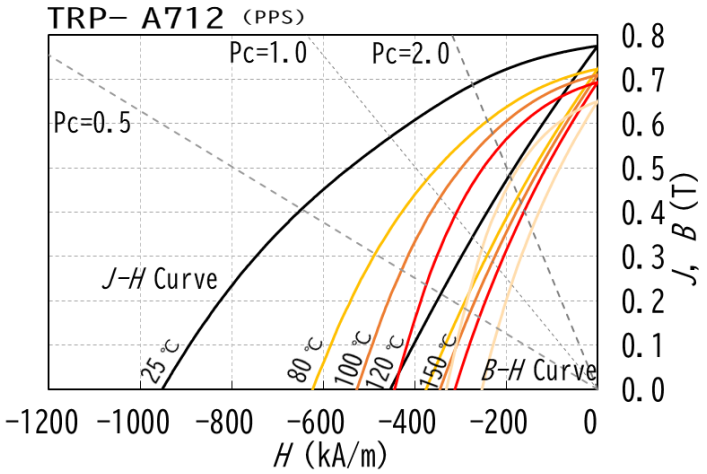


Temp. (℃)	80	100
α_{Br} (%/℃)	-0.26	-0.23
β_{Hcj} (%/℃)	-0.42	-0.40

Anisotropic NdFeB compound (Temperature property)

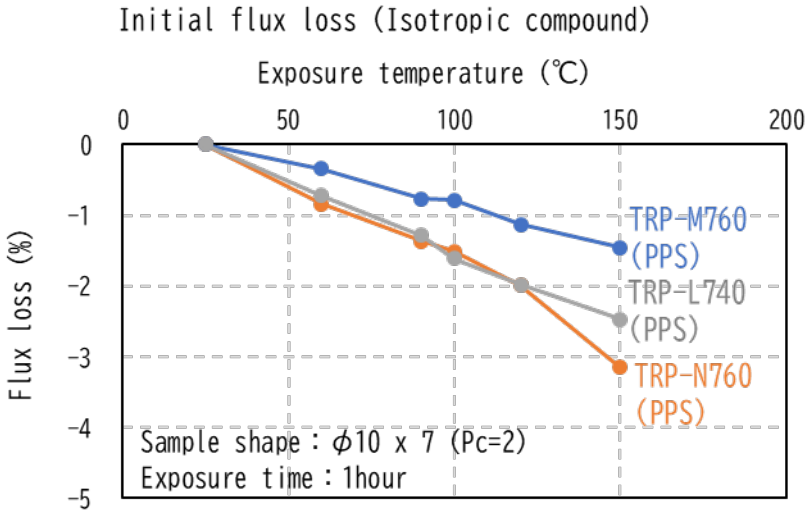


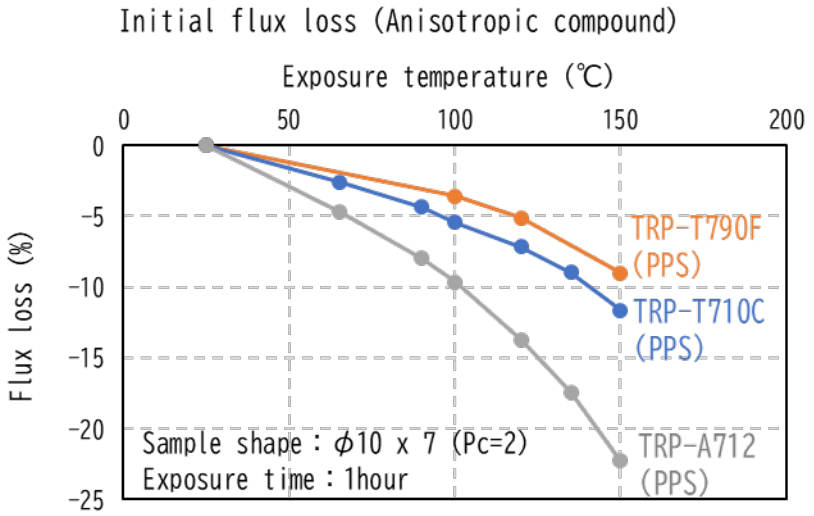
Temp. (℃)	80	100	120	150
α_{Br} (%/℃)	-0.10	-0.10	-0.11	-0.11
β_{Hcj} (%/℃)	-0.54	-0.52	-0.50	-0.47

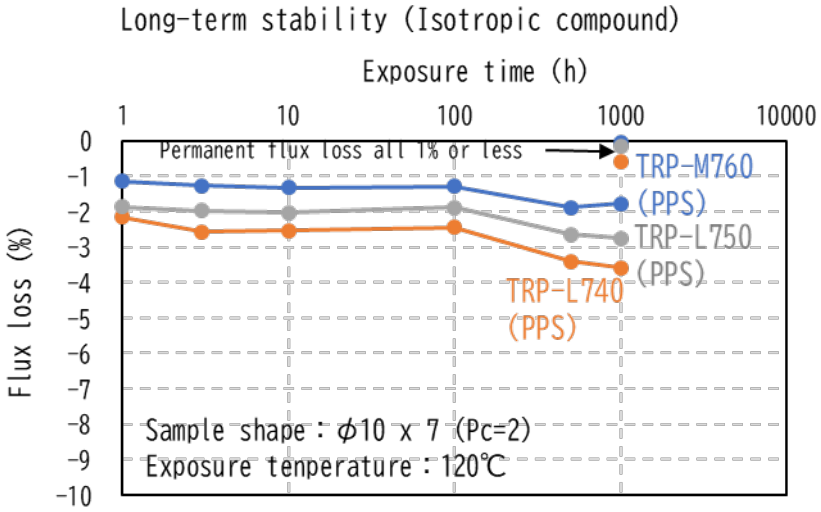


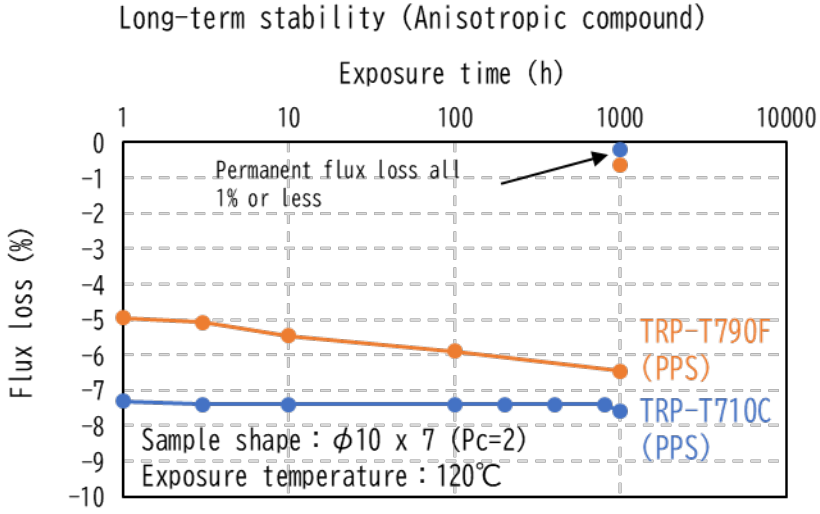
Temp. (℃)	80	100	120	150
α_{Br} (%/℃)	-0.12	-0.11	-0.11	-0.13
β_{Hcj} (%/℃)	-0.63	-0.60	-0.56	-0.52

NdFeB compound (Initial flux loss / Long-term stability)









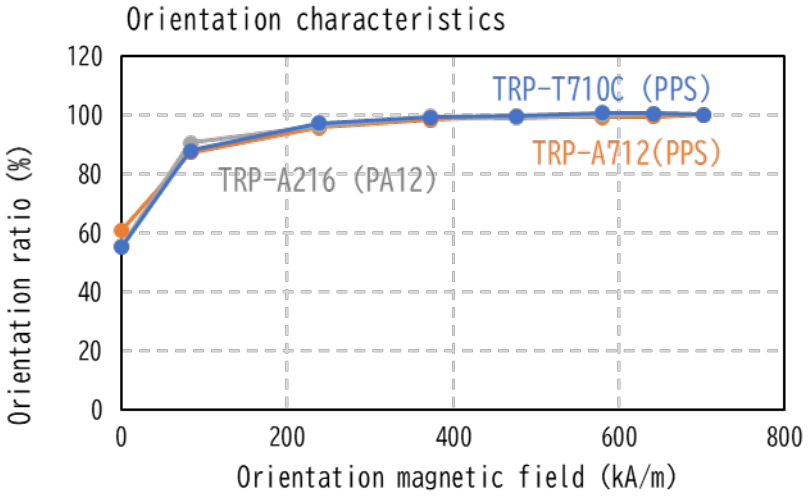
◆ Permanent flux loss is evaluated by magnetizing at 8640 kA/m after 1000h exposure.

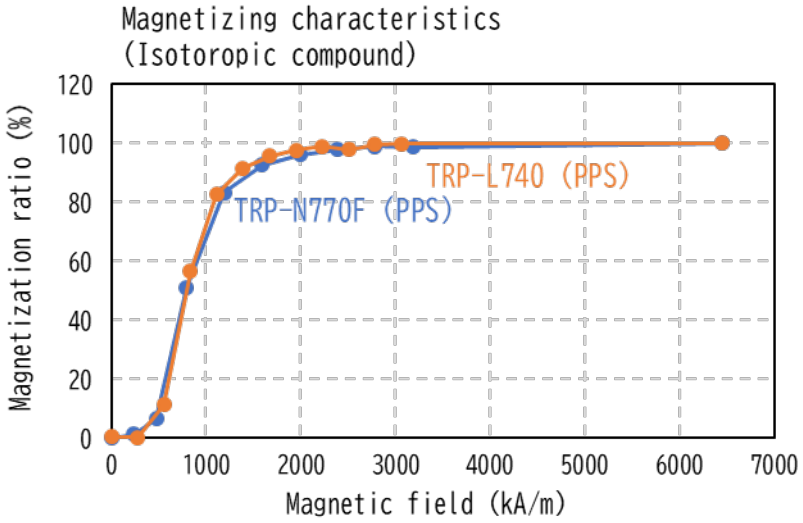
◆ **Orientation characteristics**

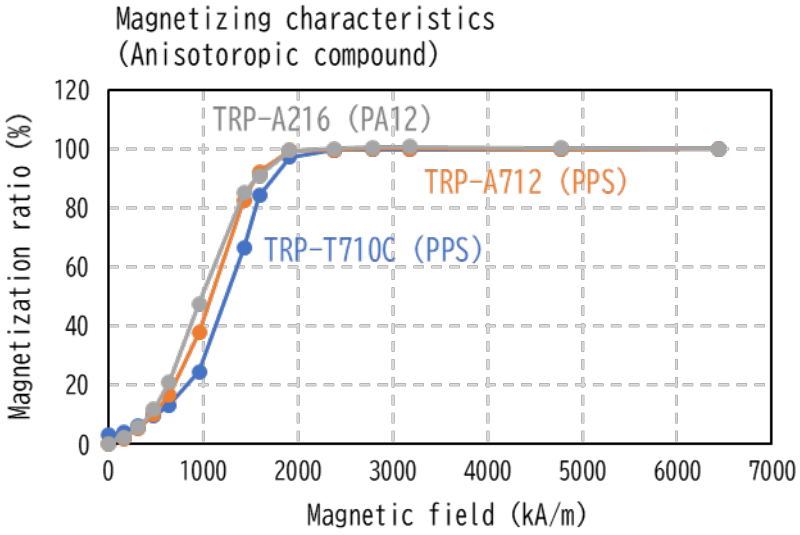
- The orientation ratio of the anisotropic compound is the result measured by magnetizing at 6450 kA/m after orientation.
- The orientation ratio of the anisotropic compound is calculated in comparison to the value at 700 kA/m as 100%.

◆ **Magnetizing characteristics**

- The magnetizing characteristics of the anisotropic compound are the results after the processing of (i) orientation at 700 kA/m, (ii) demagnetization, and (iii) magnetization.
- The magnetization ratio of the anisotropic/isotropic compound is calculated in comparison to the value at 8450 kA/m as 100%.



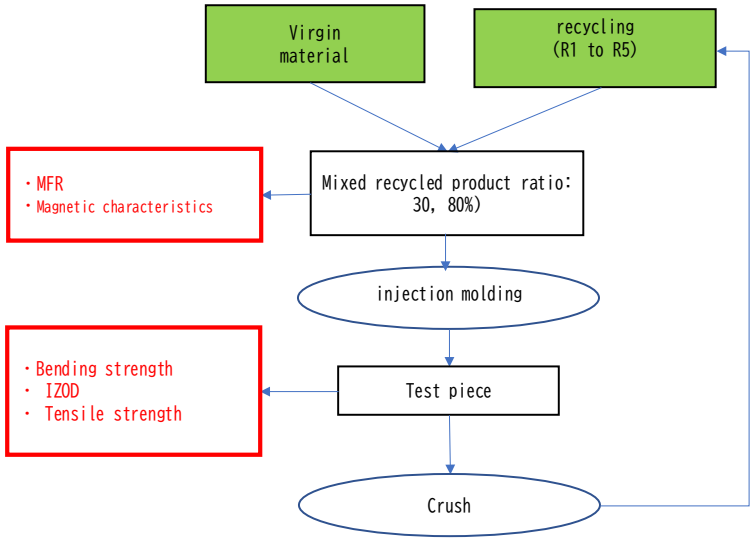




NdFeB compound (Recyclable data)

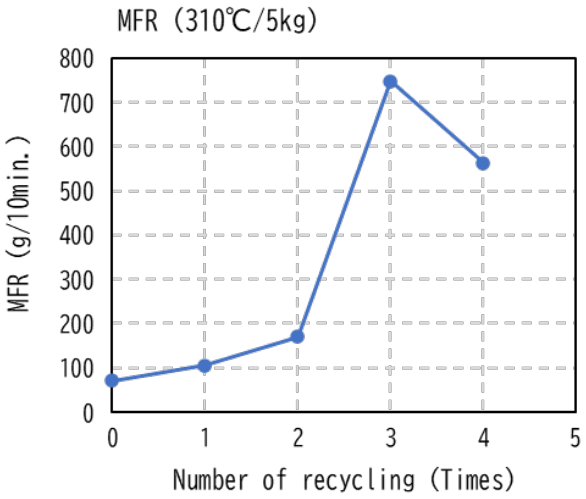
Test grade：TRP-M760 (PPS)

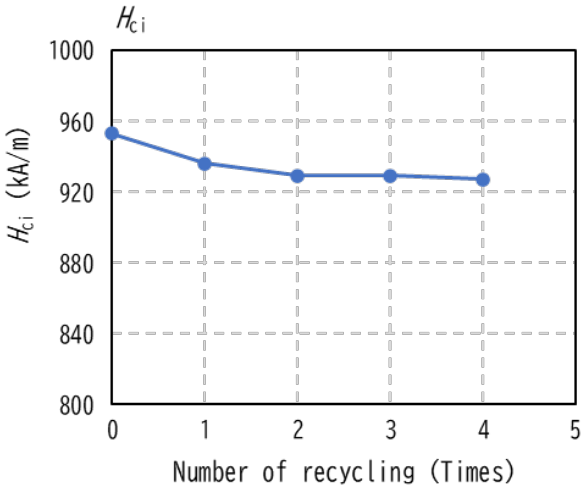
Recycling flow

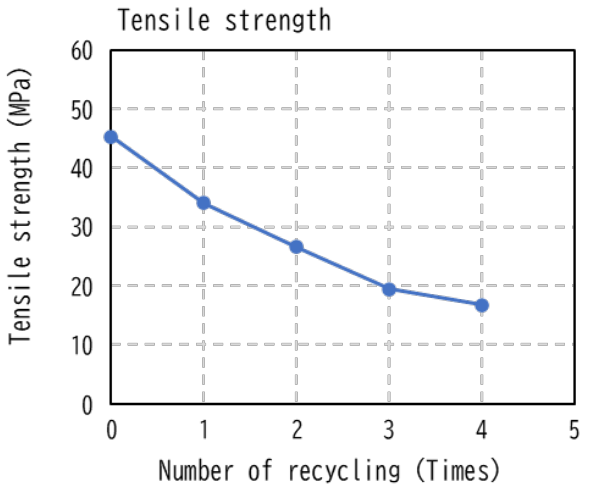


Recycling rate (%)	No.	B_r (mT)	H_c (kA/m)	H_{ci} (kA/m)	$(BH)_{max}$ (kJ/m³)	MFR (g/10min)	Bending strength (MPa)	Tensile strength (MPa))	IZOD strength (kJ/m²)
100	V	526	363	953	47.3	71	86	45	5
	R1	525	360	936	46.8	106	63	34	4
	R2	525	359	929	46.5	170	45	27	3
	R3	522	357	929	45.8	748	36	19	2
	R4	525	357	927	46.2	563	30	17	2

＊MFR measurement conditions ：310℃/5kg

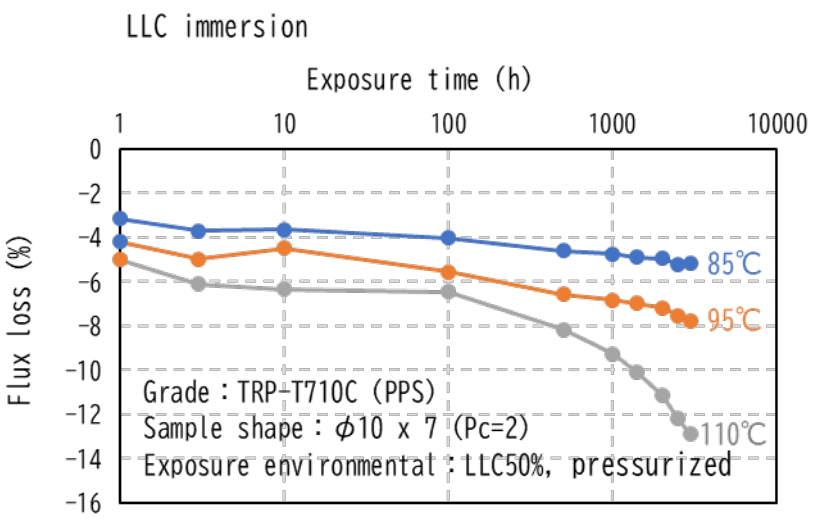




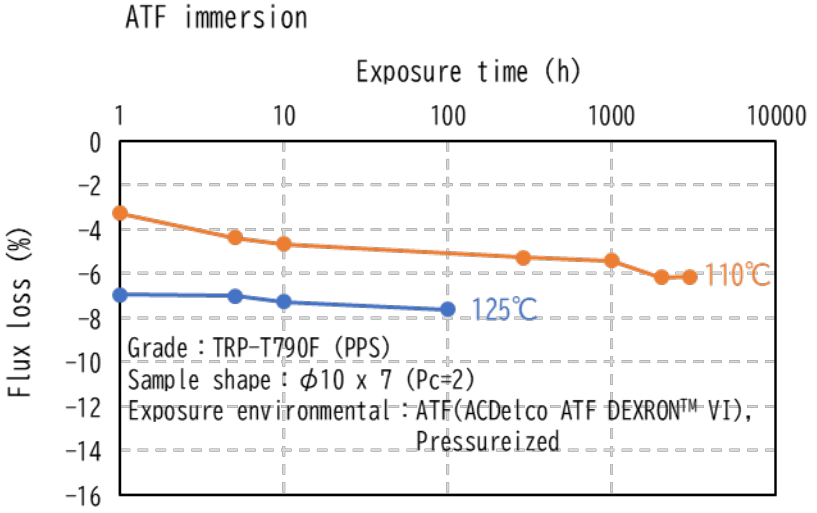


NdFeB compound (Use in automotive)

◆ Heat resistance in high temperature LLC environment

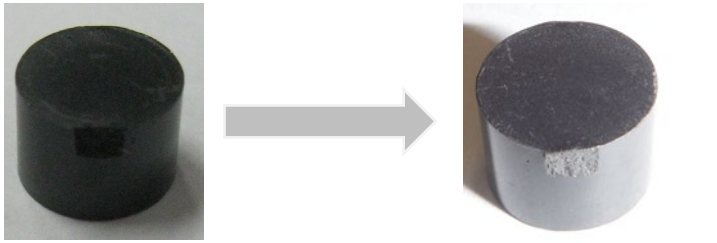


◆ Heat resistance in high temperature ATF environment



External appearance after immersion test

Even after immersion at 110 °C for 3000 hours, no rust occurred on molded product including the gate part of the molded product.



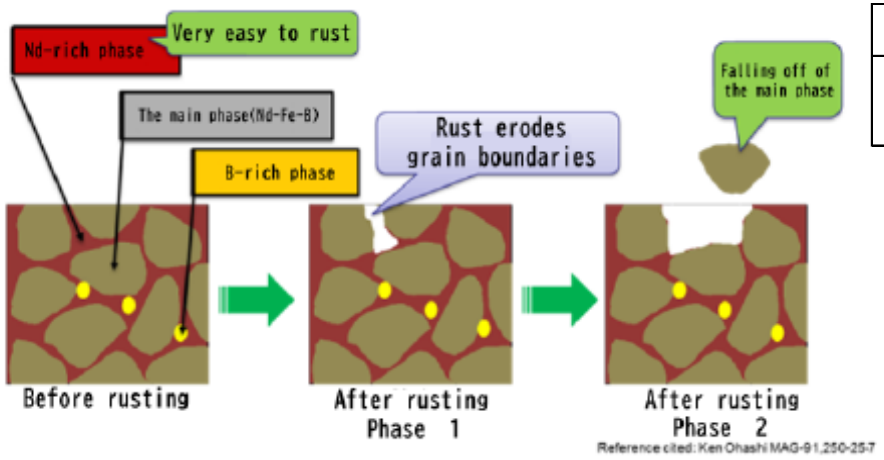
Before immersion

After soaking at 110 °C for 3000 hours

NdFeB compound (Corrosion resistance)

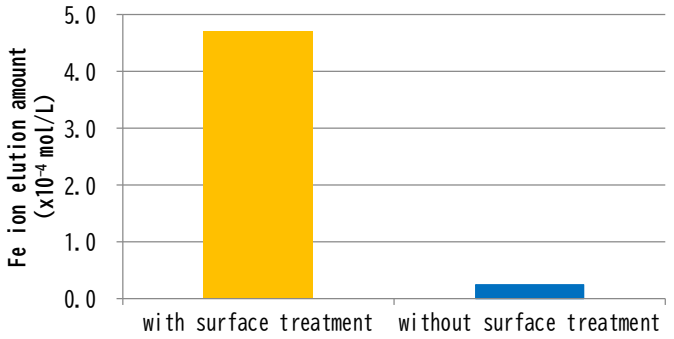
- Basically, NdFeB magnets are vulnerable to corrosion, so we apply rust preventive treatment on magnetic powders before compounding with resin.
- Our materials are enough resistant to corrosion for the use in submersible pump.

◆ Rust generation mechanism



Fe ion elution amount (mol / L)

	with surface treatment	without surface treatment	Magnification (without / with)
Elution amount	4.7×10^{-4}	2.6×10^{-5}	18.4



Rust begins from the Nd-rich phase, then the main phase will be invaded. Since this reaction does not form a passivation film, it does not stop and eventually causes the loss of the main phase. Also, Br decreases at this state.

◆Rust prevention to magnetic powders

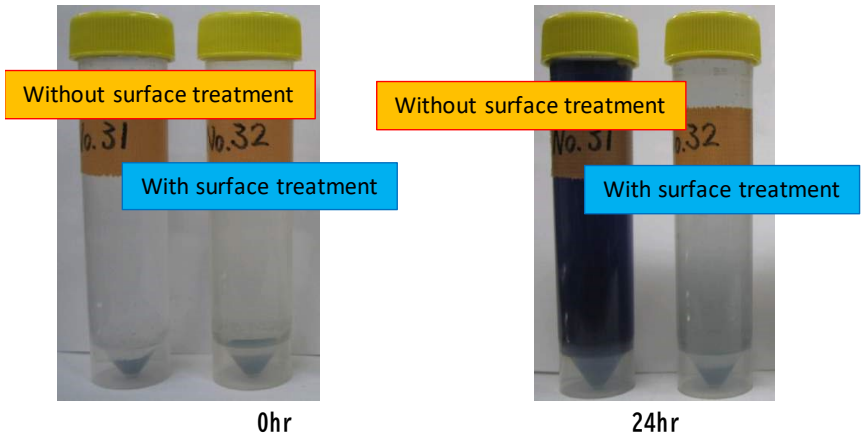
【Prevention method】

Apply special surface processing to the magnetic powders to prevent physical contact with oxygen and water.

【Evaluation method】

Result of immersion testing is shown on the right, in which 1 gram of material (magnetic powders with/without surface treatment above) is soaked in catechol solution (50 ml at 23 °C /24 hr).

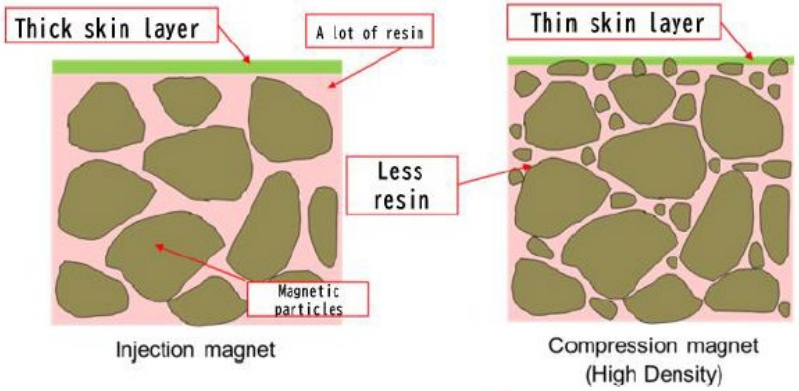
Color change of catechol solution



NdFeB compound (Corrosion resistance)

◆ **Difference in corrosion resistance between compression molded magnets and injection molded magnets**

The magnetic powders in bonded magnets are covered with more resin than those in compression magnets. This prevents contact with oxygen and water. Moreover, a skin layer is formed during molding which serves as preventive measure. The thickness of this skin layer changes depending on the injection conditions. You can select an appropriate mold design and injection conditions in order to obtain a sufficient skin layer for preventive purpose.



◆ **Effect of skin layer**

【Evaluation methods】

Immersion test in tap water (supplied in Otake, Hiroshima)

- Temperature: 26 °C
- Time: 100hr

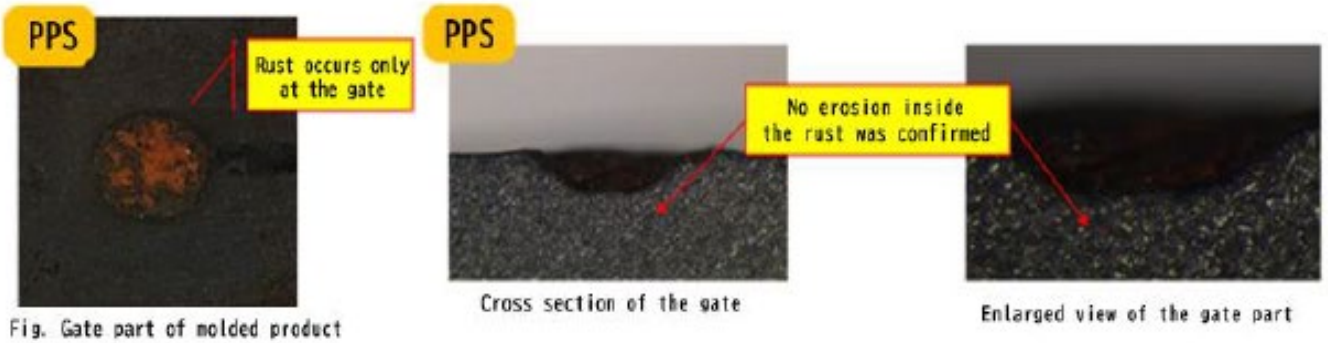


Fig. Gate part of molded product

Soft ferrite compound (Property overview)

Features

A soft magnetic compound that uses ferrite powders manufactured at our factory. Customer can combine the magnetic powders and resin as desired that suits your application. We will provide products with excellent processability that support the needs of miniaturization, complicated shapes and thinning on the customers' side.

Example of Application

- Suppression of electromagnetic noise
- Absorption of electromagnetic wave
- Magnetic shield
- Magnetic core

Property overview

Resin	Grade	Filler	Molding density	MFR	μ' at 10MHz	B at 786kA/m	Deflection temperature	Flexural strength	IZOD impact strength	Linear expansion coefficient
			ASTM-D792	ASTM-D1238	-	-	ISO75-2	ASTM-D790	ASTM-D256	JIS K 7197
			(g/㎤)	(g/10min)	(-)	(T)	(℃)	(MPa)	(kJ/㎡)	(×10-5/℃)
PA12	SP-I247AEN	Magnetic powder	5.0	400 (270℃/5kg)	10.5	1.2	112	60	9	6.6
PA6	MC100LK31	Mn-Mg-Zn ferrite	3.3	55 (270℃/10kg)	16.5	0.2	172	120	6	4.1
PPS	SP-N736	Ni-Zn ferrite	3.6	40 (300℃/5kg)	16.4	0.2	215	95	5	2.2

* Direction flatwise, bending stress 1.82 MPa

◆Preservation

- ✓ Avoid direct sunlight and high humidity; keep in a cool and dark place with stored in an airtight container.
- ✓ Nylon materials are required to be hermetically sealed, as they would take up moisture and their molding quality might be affected.
- ✓ Rare earth materials may deteriorate due to oxidation so make sure to keep hermetically sealed.
- ✓ Quality guarantee is valid for 6 months normally as long as the package is still unopened.

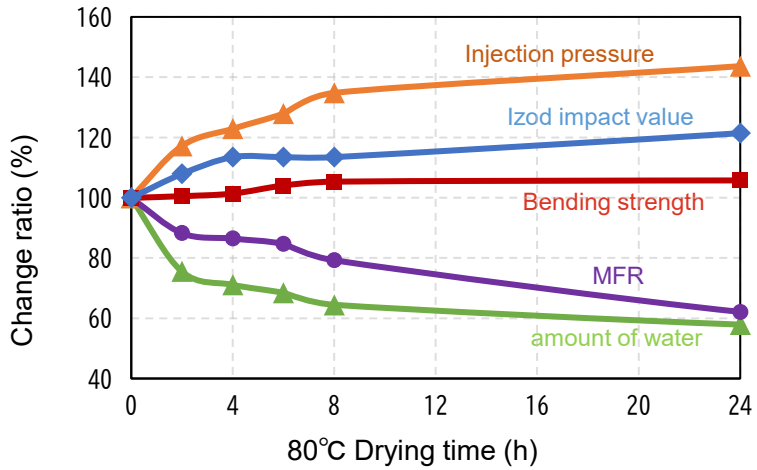
◆Pre-drying

- ✓ In order to reduce drooling from the nozzle and stabilize the molding, dry compounds in advance as necessary. Drying conditions depend on your specification of the equipment and molded products.

Resin	Drying temperature(℃)	Drying time (hr)
PA12	60 ～ 100	2 ～ 8
PA6	80 ～ 120	3 ～ 12
PPS	100 ～ 120	2 ～ 8

- ✓ Pre-drying affects the molding conditions, appearance of molded product, and properties of products as shown in the figure below. Processability will be impaired if they are absolutely dried or overdried. Orientation characteristics and magnetic force of anisotropic materials may be harmed due to the change in fluidity.
- ✓ Drying conditions depend on the season and the specification of your product.

TP-A27N (Fr-PA12) effect of pre-drying



◆ Molding machine / mold design

- ✓ Please use abrasion resistance cylinders and screws for the molding machine.
- ✓ Provide gas drainage of the mold in all parts including product parts and runner parts.
- ✓ When magnetic field molding is performed, materials are attracted to the magnetic force therefore fluxional behavior might be affected. Please note that the weld position and gas drainage position are different from those of normal resin.

◆ Temperature setting

- ✓ The viscosity of magnetic compounds is fluctuated by the melting temperature and residence time. Excessive temperature or stagnation may cause solidification or decrease in strength due to deterioration of the resin.
- ✓ Be sure to purge immediately before molding. Once the molding machine stops or is blocked, it needs to be re-purged.
- ✓ Please be aware for pin gate molding that the gate sealing time is short and pressure after gate seal tends to cause problems such as runner removal.
- ✓ The mold temperature depends on the shape and thickness of molded products. Generally around 80°C for Nylon materials.

Resin	Cylinder temperature (℃)	Mold temperature (℃)
PA12	220 ～ 290	50 ～ 100
PA6	250 ～ 300	60 ～ 100
PPS	290 ～ 340	120 ～ 150

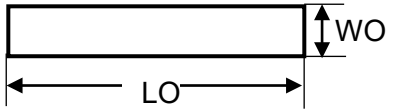
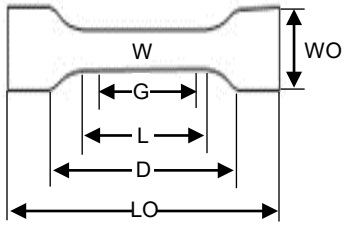
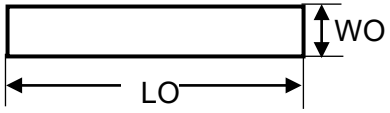
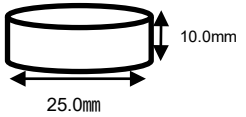
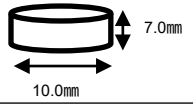
◆ Filling pressure

- ✓ Since the filler is filled higher than general resin, the products become solidified faster and higher pressure is required.
- ✓ Anisotropic materials tend to reach high magnetic force and become uniformized by shortening the filling time.

◆ Recycling

- ✓ When using recycled materials, please test in advance and pay attention closely to their quality. Also, please follow the above-mentioned instructions including preservation and pre-drying procedure of recycled materials.

Shape of test piece

Test		Test pieces	
For physical property (Strength)	Bending strength measurement	Shape: Flat plate WO (full width)：12.7mm±2 T (thickness)：3.2mm±0.4 LO (total length)：80mm±10	
	Tensile strength measurement	Shape: Flat plate (dumbbell) W (width of thin part)：13mm±0.5 WO (full width)：19mm±6.4 T (thickness)：3.2mm±0.4 LO (total length): maximum175mm G (gauge length)：50mm±0.25 L (length of thin part)：57mm±0.5 D (distance of grip)：115mm±5	
	Izod impact strength measurement	Shape: Flat plate WO (full width)：12.7mm±2 T (thickness)：3.2mm±0.4 LO (length)：60mm +	
For magnetic property	Ferrite / Isotropic rare earths compound magnetic property measurement	Shape: Cylinder φ (diameter)：25mm h (height)：10mm	
	Anisotropic rare earth compound magnetic measurement	Shape: Cylinder φ (diameter)：10mm h (height)：7mm	

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Ver. Dec. 2023