Materials Mag!c

HITACHI

Catalog

YSS High Quality Plastic Mold Steels

HI-PM Series

In compliance with advanced plastic molding technology

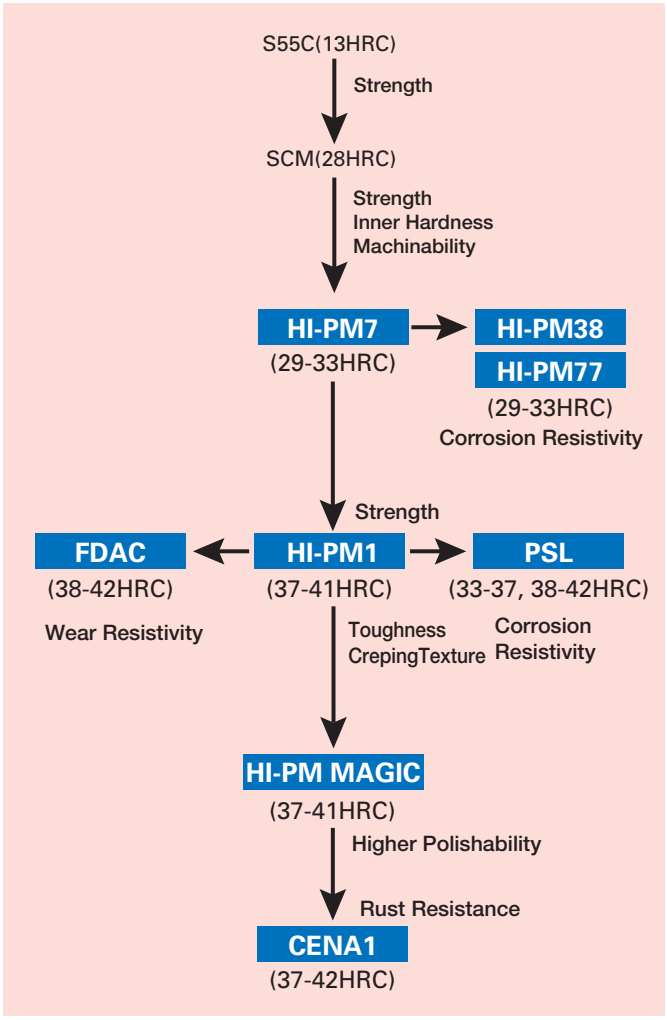
YSS plastic mold steels "HI-PM" series are increasing popularity in compliance with advanced plastic molding technology. "HI-PM" series are fulfilling demands of plastic industry for molds that provide crepe-and mirror-finishability and mold durability for corrosive gas generating and reinforced resins.

Hitachi Metals, Ltd.

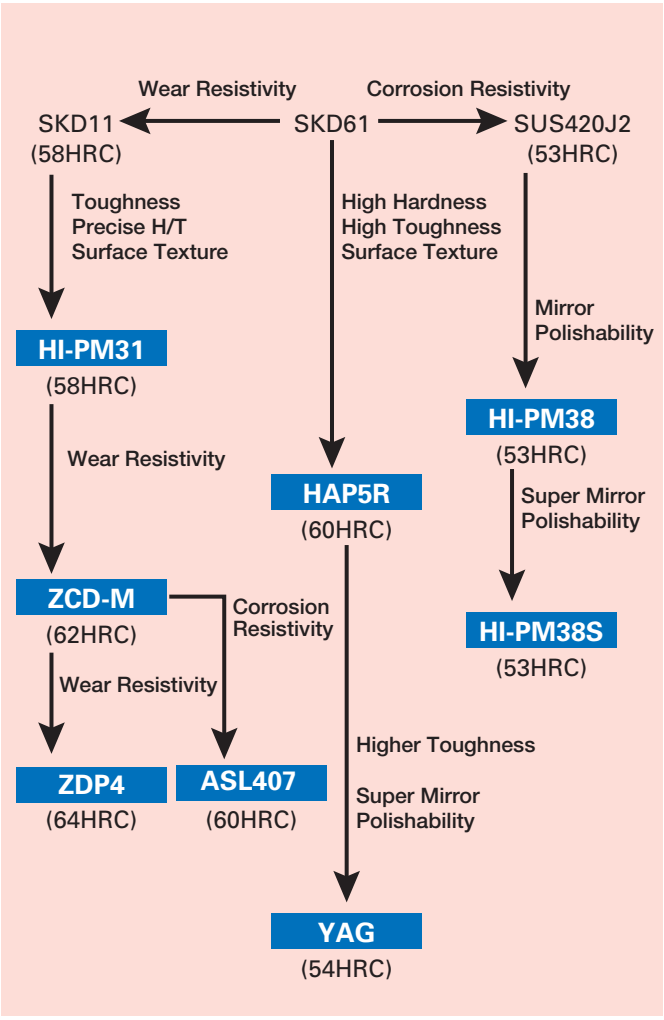
Mold Material and Application

Group	Hardness Employed (HRC)	Grade	Material Type	Application Example
Prehardened	29~33	**HI-PM7**	P20 improved	Mold required good weldability & machinability (Autoparts, Home electronics, House equipment)
		HI-PM38	420 improved	Flame retardant resin, Transparent parts, Rubber
		HI-PM77	420 improved & resulpherized	Corrosion resistant mold bases, Rubber mold
	(Round Bar) 38~42 (Flat Bar) 33~37	**PSL**	630 improved	Mold for polyvinyl chloride, Frothy resin, Rubber
	37~42	**CENA1**	Cr contained NiAl precipitation grade	Rust resistant mold with sensitive surface as mirror polishing, creping, EDM, Weldless Mold
	37~41	**HI-PM MAGIC**	P20 improved	General Mass-Production Mold (Autoparts,OA equipment,Home
		HI-PM1	P21 improved & resulpherized	Mold for general use (Home electronics etc), Plate & holder
	38~42	**FDAC**	H13 improved & resulpherized	Engineering resin, Slide core
For Quench and Temper	50~55	**HI-PM38**	420 improved	Mold for Anti-corrosion / Mirror polish (Casette, Medical instruments, Food container, etc)
		HI-PM38S	420 improved	Mold for super mirror polish (Optical disc / Lense)
	56~62	**HI-PM31**	D2 improved	Wear resistant mold for engineering resin (Gear, Connector, IC)
		HAP5R	P/M HSS	Mold required high toughness & high hardness (Core pin, Thin wall)
	60~63	**ZCD-M**	D2 improved	IC mold
	60~65	**ZDP4**	P/M Cold Die Steel	Reinforced and flame retardant engineering resin, IC mold, Slide parts, Cutter required exceptional wear resistance
For Aging	40~45	**HI-PM75**	High hardness, non-magnetic, resulphurized	Molding in magnetic field (Plastic magnet)
	52~`57	**YAG**	Maraging Steel	Mold required exceptional toughness (Core pin, Thin wall), Super mirror polish (Optical lense)
	58~61	**ASL407**	Preciptation hardning stainless steel	Advanced engineering resin, corrosion and wear resist

Sequence by Technical Needs



General Mold (Prehardened Steel)



Precise Mold (Steel for Hardening)

Properties Comparison Table

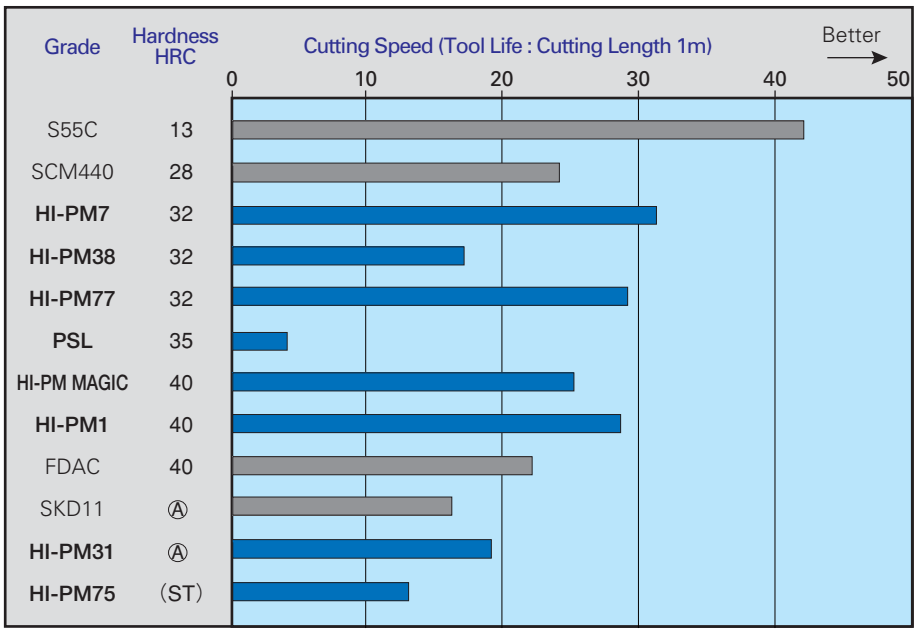
	Machinability	Heat deformation	EDM/Creping texture	Mirror polishability	Weldability	Rust resistance	Wear resistance	Toughness	Cost
HI-PM7	5	—	3	3	5	2	2	4	4
HI-PM77	4	—	2	2	3	4	2	3	3
PSL	2	—	4	3	5	5	2	4	2
CENA1	3	—	5	4	3	3	2	3	2
HI-PM MAGIC	4	—	4	3+	5	2	2	4	3
HI-PM1	5	—	2	2	2	2	2	2	3
FDAC	3	—	2	2	3	2	3	3	3
HI-PM38	3	5	5	5	3	4	3	3	2
HI-PM38S	3	5	5	5+	3	4	3	3	1
HI-PM31	3	4	5	4	2	3	4	3	2
HAP5R	3	3	5	4	2	1	4	4	1
ZCD-M	2	3	5	2	1	3	4	2	2
ZDP4	1	2	4	4	1	3	5	1	1
HI-PM75	1	4	2	2	1	4	3	3	1
YAG	2	4	5	5	5	2	3	5	1
ASL407	3	5	5	5	2	5+	3	1	1-
S55C	5	—	3	1	3	1	1	3	5
SCM440	3	—	3	2	2	2	2	3	4

Ratings : 5–Best 3–Ordinary 2,1–Poor
(Remarks) Please refer above as general concept.

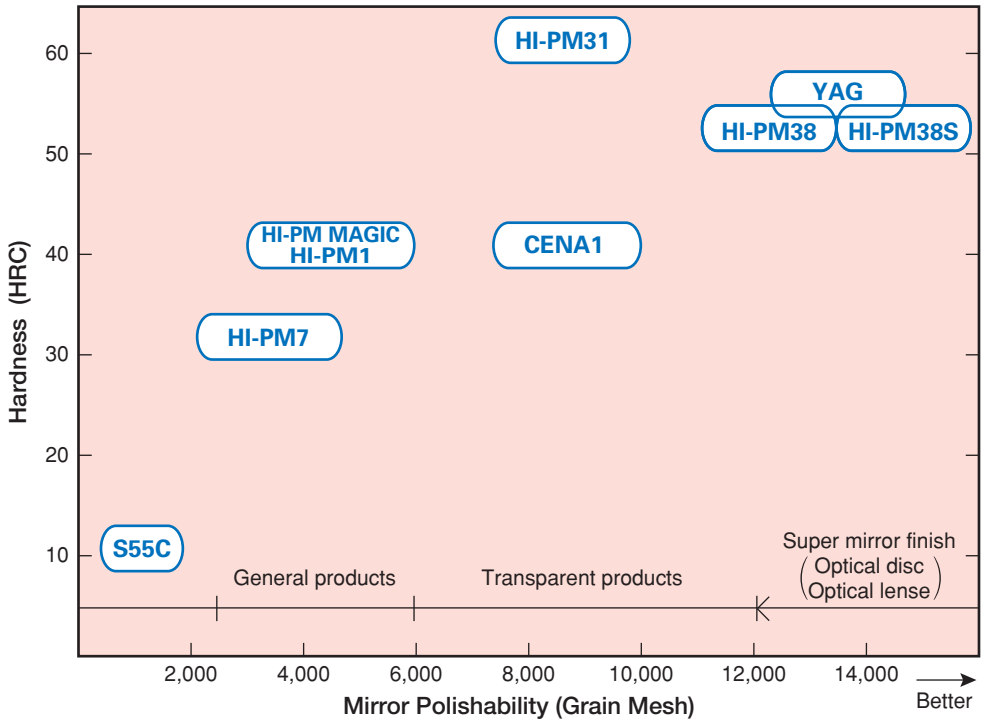
Properties Comparison

Machinability

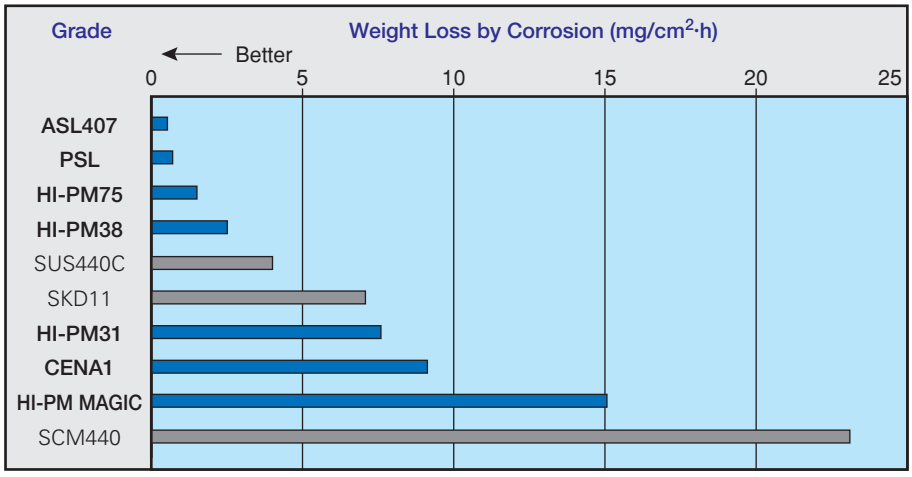
Drilling
Tool: SKH51 ϕ10
Feed: 0.15mm/rev
Depth: 30mm
Dry



Polishing Property
(Schematic Diagram)



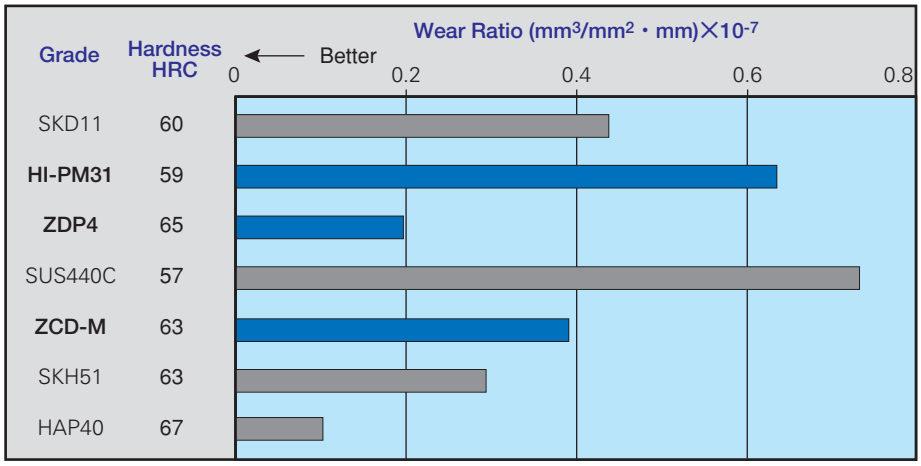
Corrosion Resistance
(5%Sulfuric Acid Solution)



Properties Comparison

Wear Resistance

Ohgoshi Wear Test
Work Material: SMC615
Load: 67N
Total Friction Length: 400m
Friction Speed: 0.78m/sec



Mechanical Properties

Grade	Hardness (HRC)		Tensile Strength (N/mm²)	0.2%Yield Strength (N/mm²)	Elongation (%)	Reduction of Area (%)
HI-PM7	32		975	855	20	55
HI-PM38	52		1,910	1,620	13	35
HI-PM77	32		990	845	16	41
PSL	39		1,170	1,100	11	34
CENA1	40		1,225	1,150	15	50
HI-PM MAGIC	40		1,200	1,020	18	45
HI-PM1	40	L	1,225	1,030	18	40
		T	1,215	1,010	10	25
HI-PM75	42		1,305	1,110	11	28
YAG	53		2,010	1,910	10	48

Physical Properties

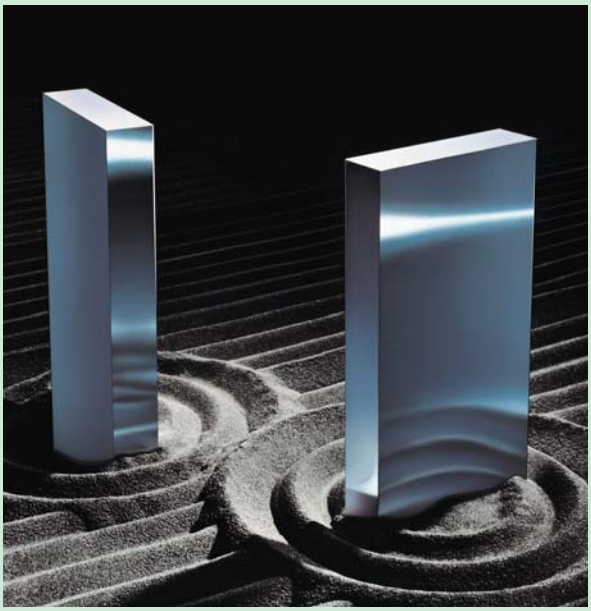
	Thermal Expantion Coef. (x10⁻⁶/℃) Averaged value from 30℃ to each temp.				Thermal Conductivity (W/m・K)				
Grade	100℃	200℃	300℃	400℃	20℃	100℃	200℃	300℃	400℃
HI-PM7	11.6	12.2	12.8	13.4	34.3	38.3	39.8	40.4	40.6
HI-PM38	10.4	11.1	11.5	11.8	22.1	25.5	26.7	28.5	29.6
HI-PM77	10.1	10.7	11.1	11.5	22.3	24.9	26.3	27.9	29.5
PSL	10.6	11.1	11.9	12.1	15.8	20.0	22.2	24.2	25.5
CENA1	10.8	11.5	12.0	12.4	20.5	22.9	25.9	28.2	30.5
HI-PM MAGIC	11.5	12.3	12.9	13.4	31.4	34.1	37.7	40.2	41.1
HI-PM1	11.4	11.8	12.3	12.8	31.5	36.6	38.4	39.4	40.1
HI-PM31	12.4	13.1	13.6	14.1	22.1	25.5	26.7	28.5	30.0
ZCD-M	10.5	10.8	11.5	11.9	16.4	19.4	22.0	25.3	24.4
HI-PM75	16.1	17.2	18.0	18.6	12.3	14.5	16.4	18.7	20.4
YAG	—	10.8	—	—	20.9	—	25.5	—	27.6
ASL407	10.6	11.1	11.5	11.9	11.6	13.4	15.5	17.9	22.9

Resin Types and Grade Selection

Resin		Required Properties for Mold	Required Life and Grade Recommended			
			SHORT <10 million	MEDIUM <50 million	LONG <100 million	MASS PRODUCTION >100 million
Thermo-plastic	General	Machinability	HI-PM7	HI-PM7	HI-PM MAGIC CENA1 HI-PM1 FDAC	HI-PM MAGIC FDAC + Nitriding
	Engineering Resin	Wear Resistivity	HI-PM7	HI-PM7 + Nitriding	HI-PM MAGIC FDAC + Nitriding	HI-PM38 HI-PM31
	Reinforced	High Wear Resistivity	FDAC HI-PM MAGIC HI-PM1	HI-PM MAGIC FDAC + Nitriding, Plating	HI-PM31	HI-PM31+Plating ZDP4 HAP40
	Flame Retardant	Corrosion Resistivity	HI-PM38 (Prehardened) CENA1	HI-PM38 PSL	HI-PM38	HI-PM38+Plating ASL407
	Transparent	Mirror Polishability	CENA1	CENA1 HI-PM38	HI-PM38	HI-PM38
Thermoset	General	Wear Resistivity	HI-PM MAGIC HI-PM1 FDAC	HI-PM MAGIC HI-PM1 FDAC + Plating	HI-PM31	HI-PM31
	Reinforced	High Wear Resistivity	HI-PM MAGIC FDAC + Nitriding	HI-PM31	HI-PM31 ZCD-M +Plating	ZDP4 + Plating

General Resin : PS, PE, PP, AS, ABS etc.
Engineering Resin : PC, PPE, PA, POM, PBT, PET etc.
Advanced Engineering Resin : PPS, PI, PES, PEEK etc.

Isotropy



Yasugi works acquired International Organization for Standardization ISO9002 and ISO14001.

QUALITY ASSURANCE JIC
REGISTER FIRM
No.0076, No.0077

Accredited by RvA
86-93

JAB
QS Accreditation
R002

HI-PM MAGIC

Prehardened：37～41HRC
Advanced Plastic Mold Steel for general purposes

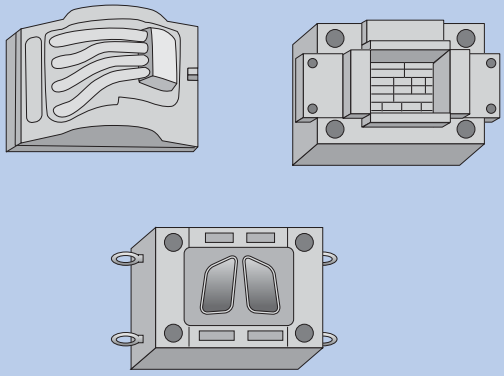
HI-PM MAGIC is a newly developed grade which has both high durability and excellent processability. Easy weldability will make setup of the new products of home electronics, OA equipments or Auto parts smoother.

Features

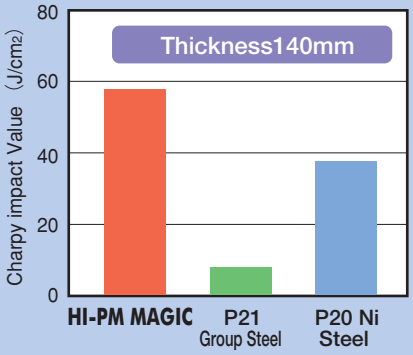
- No heat treatment is necessary. (37～41HRC)
- Good and stable polishability
- Steady machinability. Fits for high-speed high feed cutting
- Higher toughness compared with conventional 40HRC grades
- Easy Weldability
- Excellent nitriding properties
- Good EDM finishability
- Satisfying Cost Performance

Application

- General resin products for home electronics, OA Auto and so on.



Home electronics,
OA equipment, Auto parts



Comparison of 2mmU notch Charpy impact values, classified by material dimensions
(example of measurement by our company)

HI-PM1

Prehardened：37～41HRC
Free Machining Precipitation Hardening Grade for Precise Mold

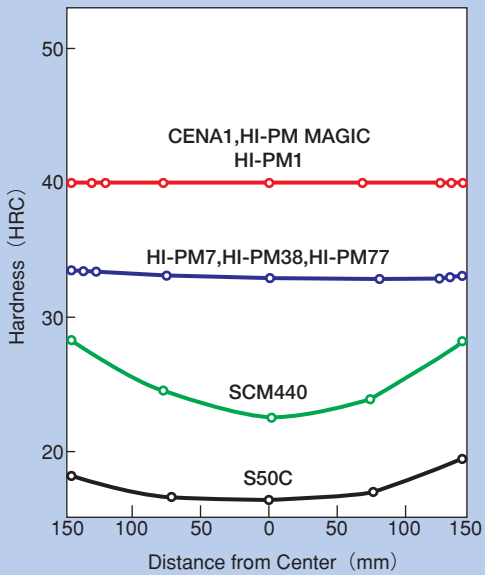
HI-PM1 is free machining plastic mold steel prehardened to 40HRC manufactured by consumable electrode remelting process.With superb machinability, HI-PM1 is fitted for genaral applications.

Features

- No heat treatment is necessary. (37～41HRC)
- Excellent machinability among 40HRC prehardened grades.

Application

- General Plastic Products
- Precise Rubber Mold, etc. For Smooth Cut Surface.



Cross Section Hardness Distribution
(300mm Square Size)

CENA1

Prehardened：37～42HRC

Precipitation Hardening, Rust-Resisting Grade for Precise Mold

CENA1 is new concept grade breaking through with rust resistivity and excellent machinability. CENA1 is manufactured by consumable electrode remelting method, having exceptional high purity and suit for critical surface finish.

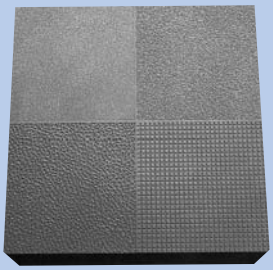
Features

- No heat treatment is necessary. Uniform hardness distribution. (37～42HRC)
- Higher rust resistivity compared with P21 type grade.
- Excellent machinability makes machined surface better.
- Excellent mirror polishability, crepe- and EDM finishability.
- Good weldability with least hardness elevation.
- Good nitrinding hardenability and can be used for wear resisting application.

Application

- Most Suitable for Weldless Molding
- Countermeasure against corrosion by gas generated from resin.
- Other Critical Surface Finish Molds. Engineering resin products

TV Glossy Frame
(Weldless Molding)



Non-glare Treatment Sample

Creping Sample

EDM Sample

CENA1 100×100×50(mm)

HI-PM7

Prehardened:29～33HRC

For Medium and Large Mold for General Application

HI-PM7 is plastic mold steel prehardened to 29～33HRC fitted for medium and large size mold, having good machinability and weldability. In addition, it has good mirror polishability and EDMachinability to make itself one of the best steel in this class grade.

Features

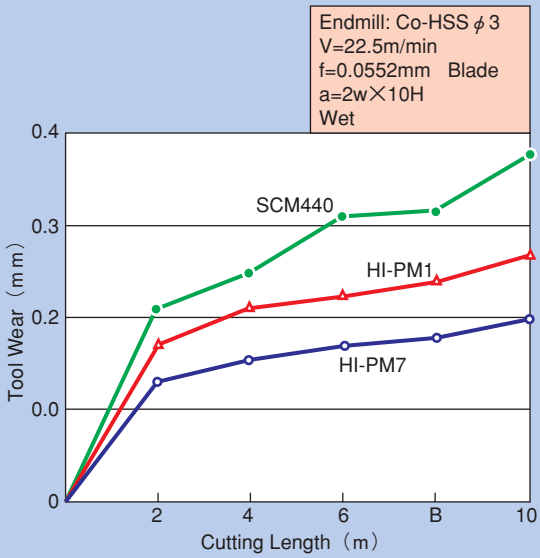
- Uniform hardness distribution even in large crosssection. (29-33HRC)
- Machinability is better than P20 or free machining steel.
- Excellent weldability with least hardness elevation.
- Good mirror polishability.
- Less streak texture and least hardness elevation on EDM surface makes finishing easier.
- Excellent toughness.
- Excellent nitriding property.

Application

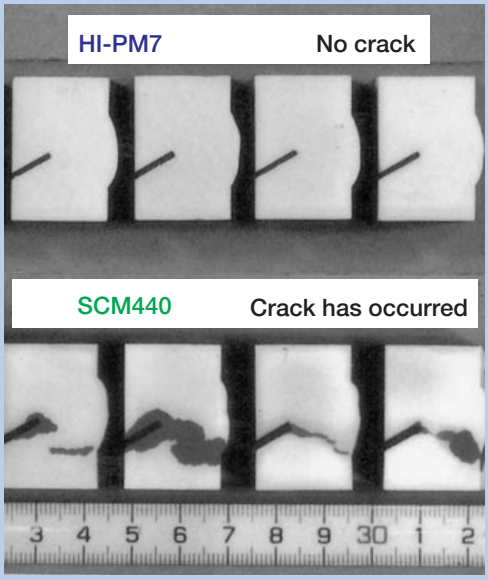
- Auto parts ex.Headlight lense, Taillamp, Inner panel etc.
- Home electronics, House equipment ex. TV cabinet, Air conditioner housing etc.
- Others large daily goods, Large container, Pipe, Rubber

Inner Panel

Tail Lamp



Machinability Comparison



y-groove Weld Crack Test
JIS Z 3158
TIG Welding
No pre-heating / No post-heating

HI-PM38

Prehardened:29～33HRC
Hardenable to:50～55HRC

For Anti-Corrosion and Mirror Polish Mold

HI-PM38 is Mo contained 13Cr martensitic stainless steel prehardened to 29-33HRC, manufactured by consumable electrode remelting method, further hardenable to 50-55HRC. It is fitted for molds which require corrosion resistance and superb mirror polishability. In addition, it suits for precise heat treatment. Excellent corrosion resistance also makes mold storage easier.

Features

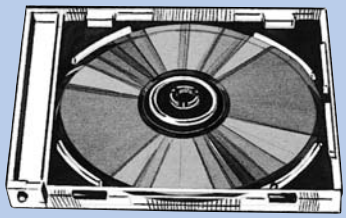
- Excellent mirror polishability
- Better corrosion-resistivity than 420. Chromium plating is not necessary.
- Least heat treatment deformation, best fitted for precise mold.
- As HI-PM38 is supplied as prehardened condition, it can be used without further heat treatment also.

Application

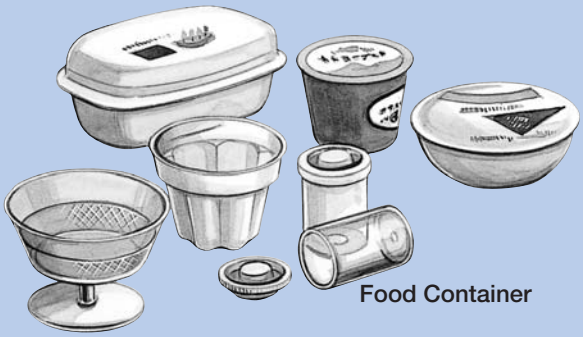
- Transparent items：Lense, Container for cosmetics, etc.
- Flame retardant resin products：Home electronics, OA equipment
- For saving plating：Food container,Medical instruments

Heat Treatment

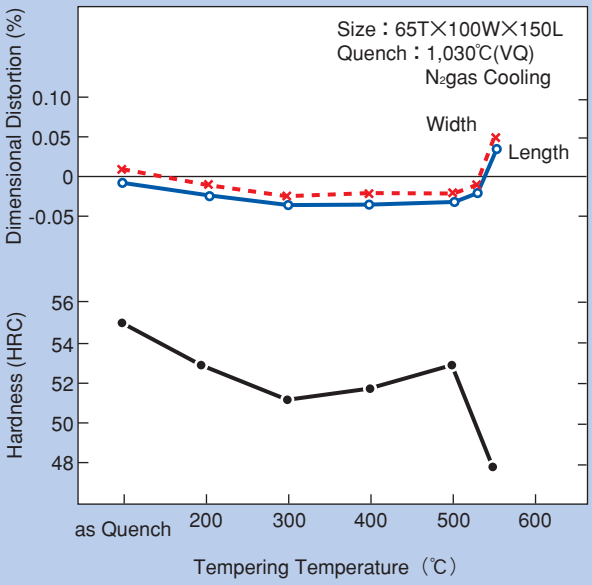
- Quenching：1,000～1,050℃ Air Cooling
- Tempering： 200～ 500℃ Air Cooling



CD,DVD



Food Container



Heat Treatment Properties of HI-PM38

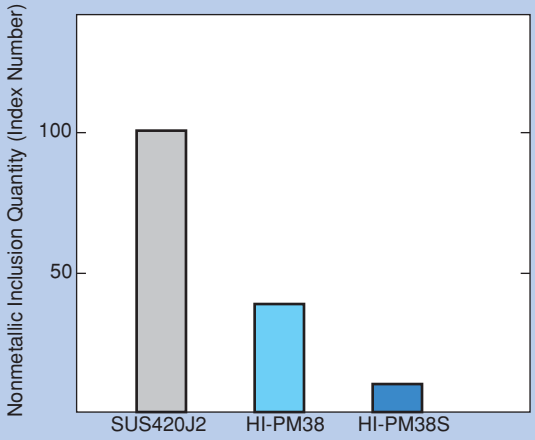
HI-PM38S

Prehardened：29～33HRC
Hardenable to：50～55HRC

For Super Mirror Polish Mold

Features

- Superior mirror polishability to below 0.01 μm surface roughness.
- Other features are same as HI-PM38.
- CD, DVD, MO, and optical lense



Purity of HI-PM38S

Prehardened Stainless Grade

PSL

Prehardened：33～37HRC（Flat bar）
38～42HRC（Round bar）

For Higher Grade Anti-Corrosion Mold

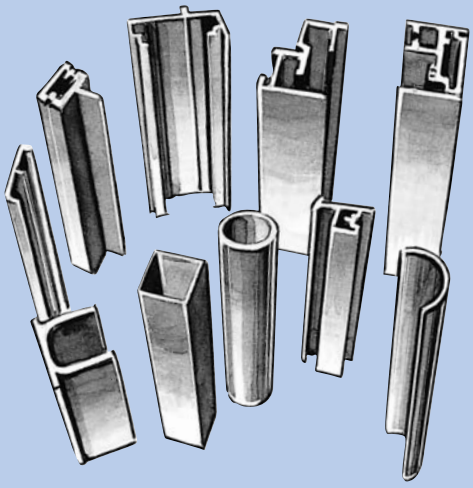
PSL is precipitation hardening stainless steel which shows superior corrosion resistance as used for corrosive gas yielding resins or resins with flame retardant additives without plating.

Features

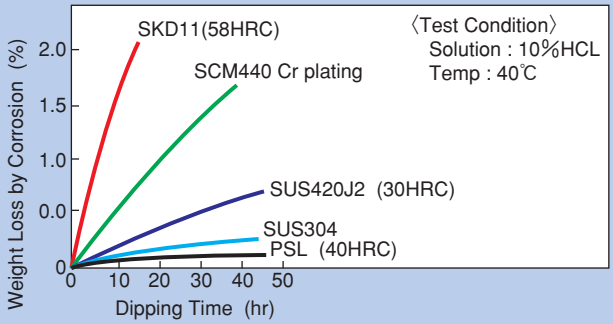
- Best corrosion resistance among plastic mold steels. Plating is not needed.
- Least hardness elevation on EDM or welded surface and easier finishing jobs.

Application

- Polyvinyl chloride : Pipe fittings, Pipe, Sash etc.
- Resins with flame retardant additives
- Precision mold for rubber



PVC Extruded Products



Corrosion Resistivity Comparison

HI-PM77

プリハードン
Prehardened：29～33HRC

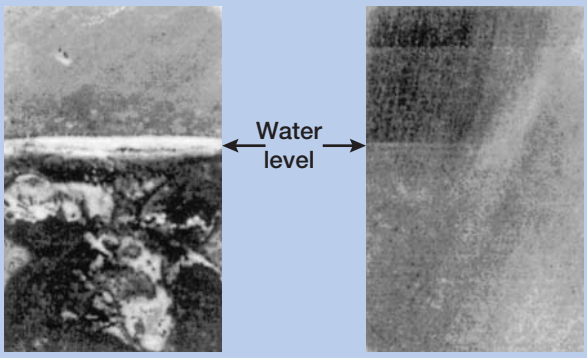
Free Machining Martensitic Stainless Grade for Mold Base

Features

- Good corrosion resistance and well fitted for rust protection of water cooling holes or surface of mold base.
- Excellent machinability
- Prehardened and good mechanical properties

Application

- Holder for compact disc mold or lense mold.
- Holder for food or medical container mold and precise engineering resin mold.
- Mold for rubber
- Anti-corrosive support tools



S55C　　HI-PM77

Rust after 1month dipping in water

High Wear Resistance Grade

HI-PM31

Hardenable to：55～60HRC

High Wear Resistant Grade for Mass Production

HI-PM31 is wear resistant plastic mold steel with fine carbide uniformly distributed by means of appropriate alloy design and consumable electrode remelting process. Least heat treatment distortion, it suits for precise heat treatment.

Features

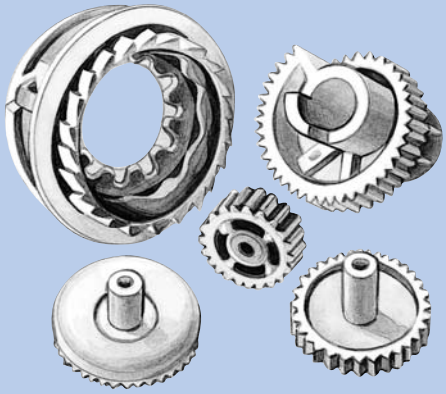
- Wear resistance is as high as JIS SKD11.
- Much better machinability and grindability than JIS SKD11.
- Least heat treatment deformation, best fitted for precise mold.
- Good mirror polishability crepe- and EDM finishability
- High hardness and toughness, enough against chipping or breakage

Application

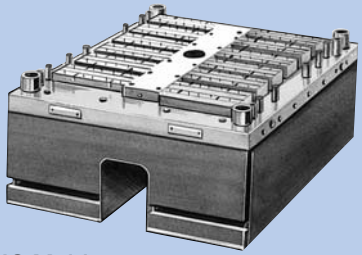
- Engineering resin products and thermosetting resin products
- Precise mold：IC mold, Connector, Watch parts, Camera parts

Heat Treatment

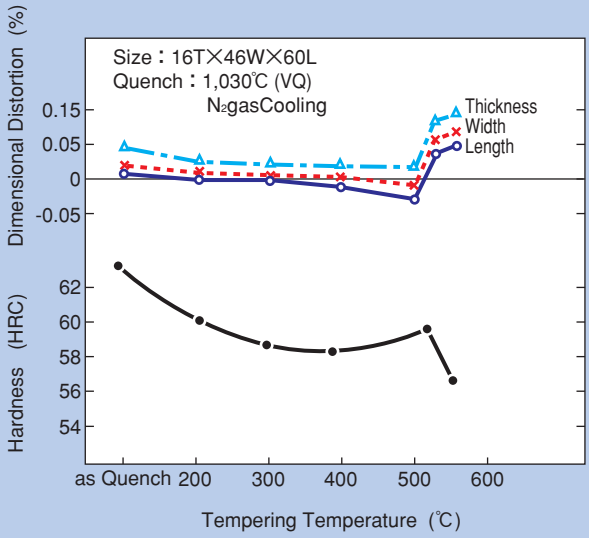
- Quenching：1,000～1,050℃ Air Cooling
- Tempering ： 200～ 550℃ Air Cooling



Engineering Resin Gear



IC Mold



Heat Treatment Properties of HI-PM31

Aging Grade

ASL407

Hardenable to：60HRC

High Corrosion Resistant And High Hardness Precipitation Stainless Steel

Features

- High hardness 60HRC can be obtained only by 490℃×5 h aging.
- Very high corrosion resistance

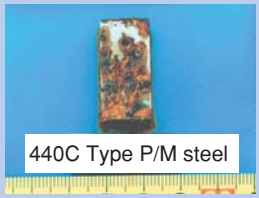
Application

- Advanced Engineering Resin Mold
- Very high corrosion resisting high hardness parts, knife etc.

Salt Spray Testing

Test Condition : Keep in 5% NaCl water solution spraying condition at 35℃

ASL407
After 2400 hour



440C Type P/M steel
After 24 hour

YAG

Hardenable to：52～57HRC

Super High Toughness Maraging Steel

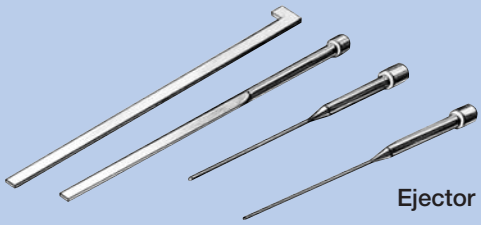
As YAG is delivered as solution heat treated condition, you are advised to conduct aging at 480～520℃ in order to get hardness between 52～57HRC after engraving cavity.

Features

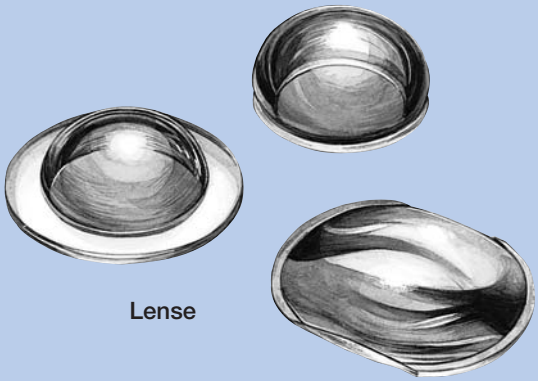
- Superior toughness and mechanical properties under high hardness and best fitted against breakage
- Super mirror polishability
- Hardness of 55HRC is obtainable by aging at 500℃ with least distortion

Application

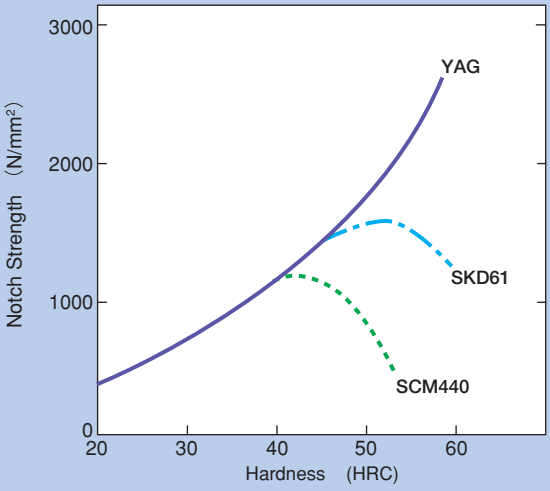
- Optical lense
- Thin core pin
- Ejector pin, either of smaller dia-meter or of longer length



Ejector Pin



Lense



Relationship between Hardness and Notch Strength

HI-PM75

Hardenable to：40～45HRC

Non-Magnetic High Hardness Free Machining Plastic Mold Steel

Features

- Permeability(μ) is 1.01, equally non-magnetic as 304
- 40～45HRC is obtainable by aging of 700℃×5h and has higher wear resistance.
- Good nitriding properties

remarks:
Slower machining recommended as it is easily hardened by machining.

Application

- Plastic magnet
- Wear resistant, non-magnetic supportive tools

Plastic Magnet

Higher Grade Polishing Method of Plastic Mold

Polish procedure example

- Polish by oil grinding stone (use kerosene) ---------- #180→#240→#320→#400→#600→#800
- Polish by oil sand paper (use kerosene) ---------- #600→#800→#1000→#1200→#1500
- Finish Polishing by diamond compound (use felt cloth) #1800→#3000→#8000→#14000
  (9μm) (6μm) (3μm) (1μm)

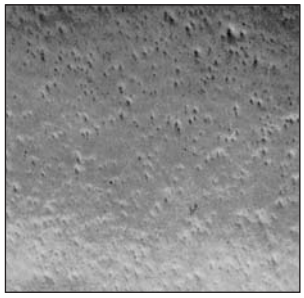
Important points of polishing

1. Each procedure is to be strictly kept.
2. When changing from one number to another, check if there are remained scrach by changing polishing direction. (move 45-90 degrees)
3. When changing numbers, wash and remove last polishing grains completely.
4. Polishing by diamond compound needs to be done in short times. Excessive polish can produce pinholes or orange peel.
5. To avoid alumina and chromium oxide as the polish capabilities are lower than diamond.
6 During long interruption, the object must be protected from the rust.

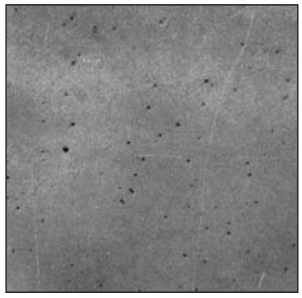
Remarks:

A. For superior polishing use diamond compound.
Don't use alumina nor chromium-oxide compound.

Diamond Compound Finish



Aluminium Oxide Finish Not Good

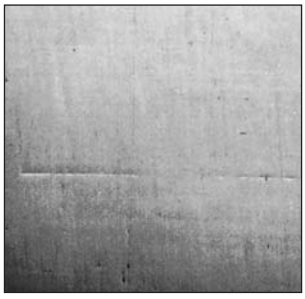


Chromium Oxide Finish Not Good

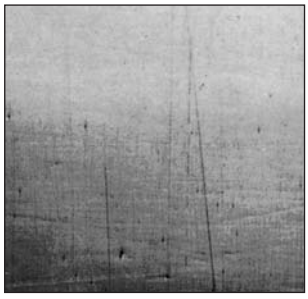
B. Load for polishing should be kept lowest possible.

C. Foregoing polish should be done prudently.

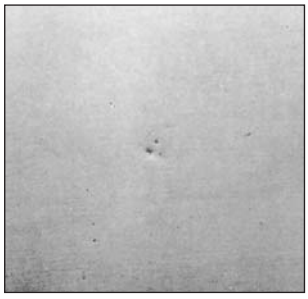
D. Rust proof measures must be taken in any interruption of jobs.



Scratch remains due to overload.



Seam and pinhole texture at crossing by less foregoing polish



Pinhole texture by inapropriate rust proof.

Welding of Plastic Mold

Attentive points

1. Preparations before welding

A. Form of location to get welded should be made smooth as Figure 1.
B. Cracks and treated surface (nitrided or plated) must be eliminated.
C. Oil, dust, moisture and scale must be removed thoroughly.

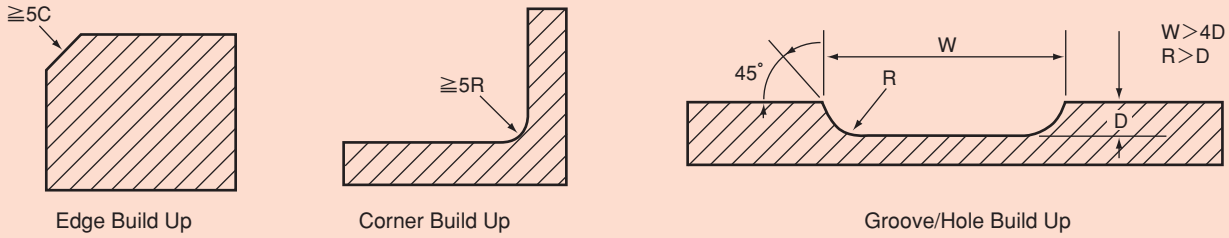


Figure 1. Standing shapes for build up welding

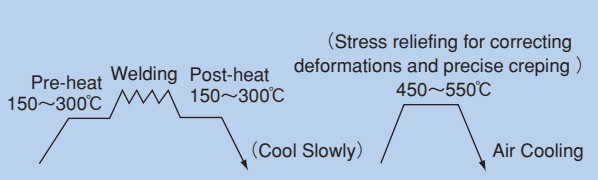
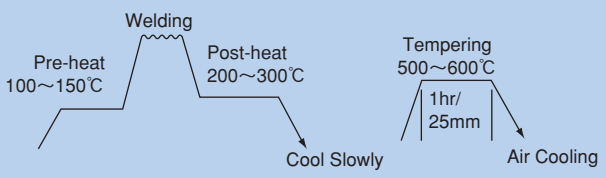
2. Welding rod

A. Welding rod of similar composition as mold is to be used so that welding may not bring about unevenness of mirror finish or creping surface.
When the mold is made from HI-PM MAGIC, use welding rod made from HI-PM MAGIC-W.
Likewise, in case fo TIG welding there are T-HTM-31 and T-HTM38 in the market for welding for mold made from HI-PM31 and HI-PM38.
B. In case of using coated electrode, mold should be dried by heating to 250-300℃.
C. For cavity welding, TIG welding should be applied. (TIG : Tungsten Inert Gas)

3. Welding

A. Figure 2 shows example of actual welding jobs of representative grades.
B. Tempering should be conducted soon after welding in case of prehardened steel or hardened and tempered steel according to Figure 2.
Tempering is effective to protect mold from crack and to stabilize mirror finish and creped surface by having uniform hardness and structure.

<table>
<tr><th>Grade</th><th>Welding</th><th>Rod</th><th>Condition</th><th>Heat Cycle</th></tr>
<tr><td>HI-PM MAGIC</td><td>TIG</td><td>HI-PM MAGIC-W</td><td rowspan="3">●TIG Welding
Rod Current
2.4φ・・・・・80～160A
3.2φ・・・・・110～200A
Flow Rate 10～15 ℓ /min

Shielded Metal Ark Welding
Rod Current
3.2φ・・・・・90～120A
4.0φ・・・・・130～160A</td><td rowspan="2"> 
</td></tr>
<tr><td rowspan="2">HI-PM7</td><td>TIG</td><td>HI-PM7-W</td></tr>
<tr><td>Shielded Metal Ark</td><td>TH-50</td><td> 
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</table>

Figure 2. Welding procedure

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