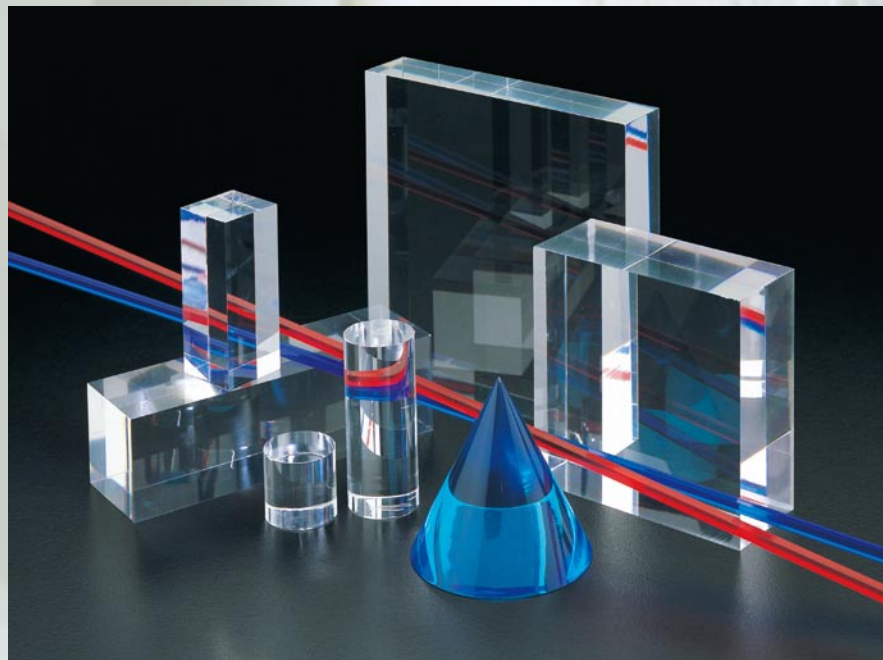
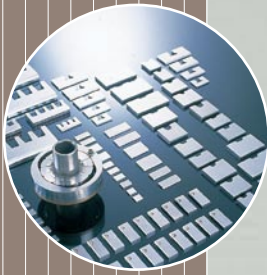


# YSS

## PLASTIC MOLD STEELS

### HPM Series



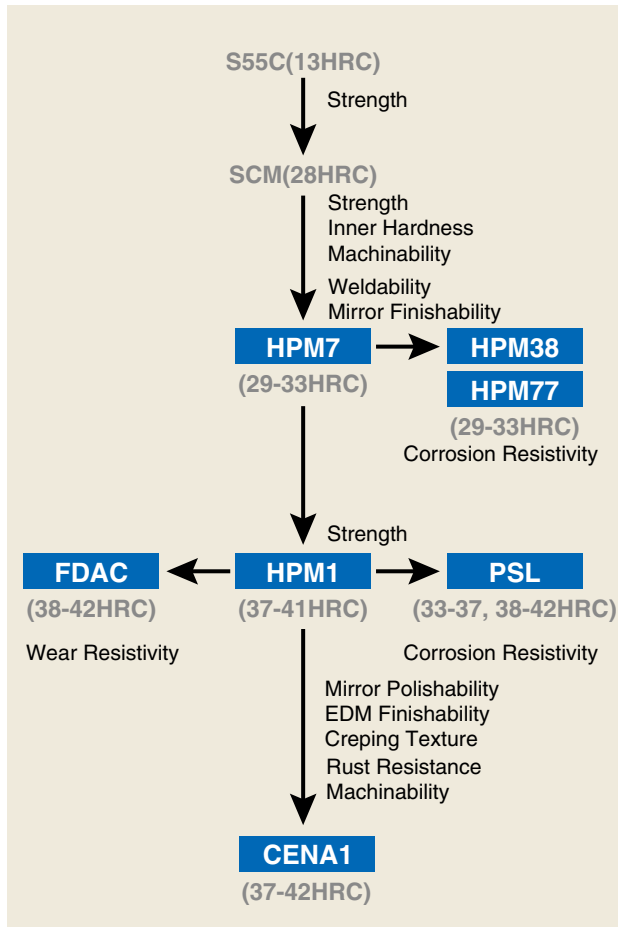
### In compliance with advanced plastic molding technology

YSS plastic mold steels "HPM" series are increasing popularity in compliance with advanced plastic molding technology. "HPM" 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.

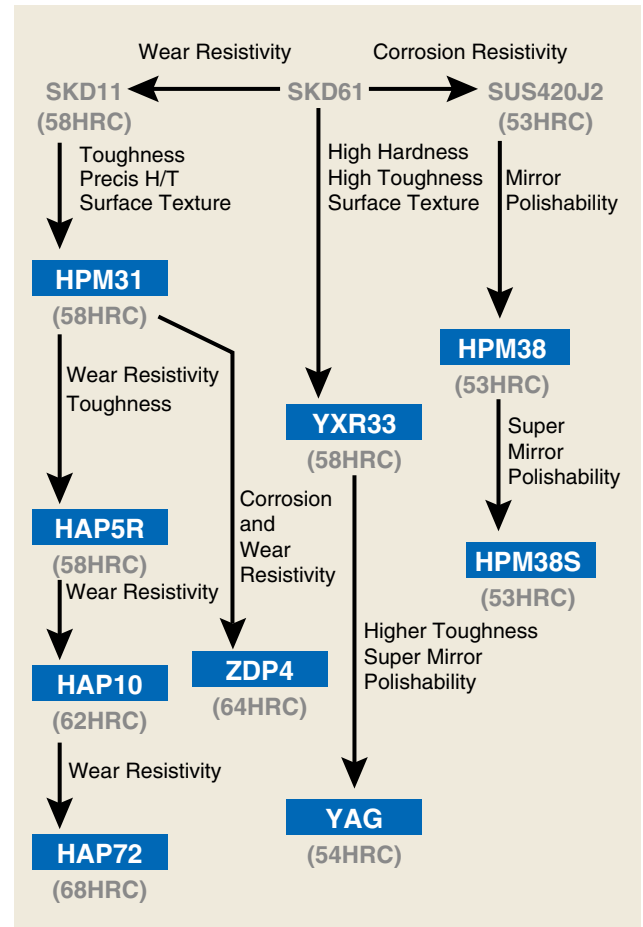
# Mold Material and Application

Group	Hardness Employed (HRC)	Grade	Material Type	Application Example
Prehardened	29~33	HPM7	P20 improved	Mold required good weldability & machinability (Autoparts, Home electronics, House equipment)
		HPM38	420 improved	Flame retardant resin, Transparent parts, Rubber
		HPM77	420 improved & resulpherized	Corrosion resistant mold plates, 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 (OA electronics, Transparent case etc)
	37~41	HPM1	P21 improved & resulpherized	Mold for general use (Home electronics etc), Plate & holder
	38~42	FDAC	H13 improved & resulpherized	Engineering resin, Slide core
	50~55	HPM38	420 improved	Mold for Anti-corrosion / Mirror polish (Floppy, Cassette, Medical instruments, Food container, etc)
		HPM38S	420 improved	Mold for super mirror polish (Optical disc / Lense)
For Quench and Temper	56~60	HPM31	D2 improved	Wear resistant mold for engineering resin (Gear, Connector, IC)
		YXR33	Matrix HSS	Mold required high toughness & high hardness (Core pin, Thin wall)
	60~63	ZCD-M	D2 improved	IC mold
	60~65	HAP10	P/M HSS	Reinforced engineering resin, IC mold
		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	HPM75	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)

## Sequence by Technical Needs



General Mold (Prehardened Steel)



Precise Mold (Steel for Hardening)

## Properties Comparison Table

Material	Machinability	Heat deformation	EDM/Creeping texture	Mirror polishability	Weldability	Rust resistance	Wear resistance	Toughness	Cost
HPM7	5	—	3	3	5	2	2	4	4
HPM38	3	5	5	5	3	4	3	3	2
HPM77	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
HPM1	5	—	2	2	2	2	2	2	3
FDAC	3	—	2	2	3	2	3	3	3
HPM38S	3	5	5	5+	3	4	3	3	1
HPM31	3	4	5	4	2	3	4	3	2
YXR33	3	3	5	4	3	3	4	4	2
ZCD-M	2	3	5	2	1	3	4	2	2
HAP10	3	3	5	4	2	1	4	4	1
ZDP4	1	2	4	4	1	3	5	1	1
HPM75	1	4	2	2	1	4	3	3	1
YAG	2	4	5	5	5	2	3	5	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

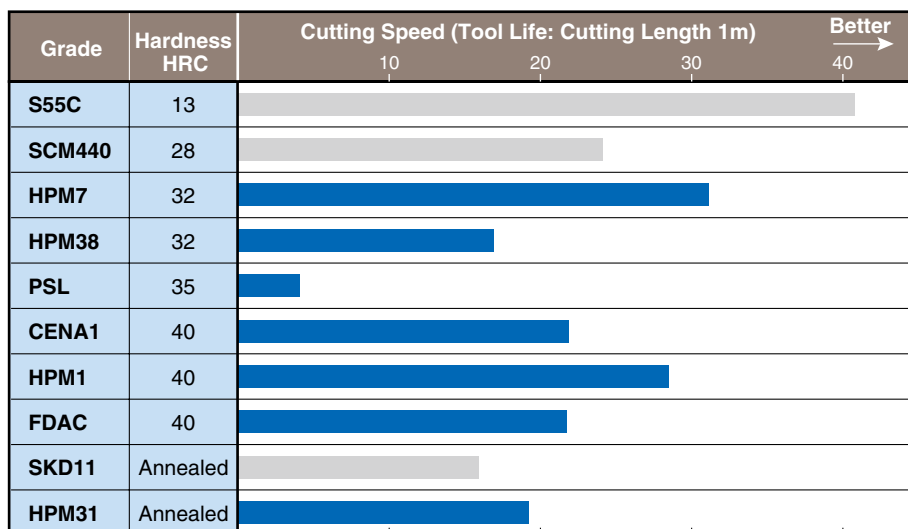
## Machinability

Drilling

Tool: SKH51 $\phi$ 10

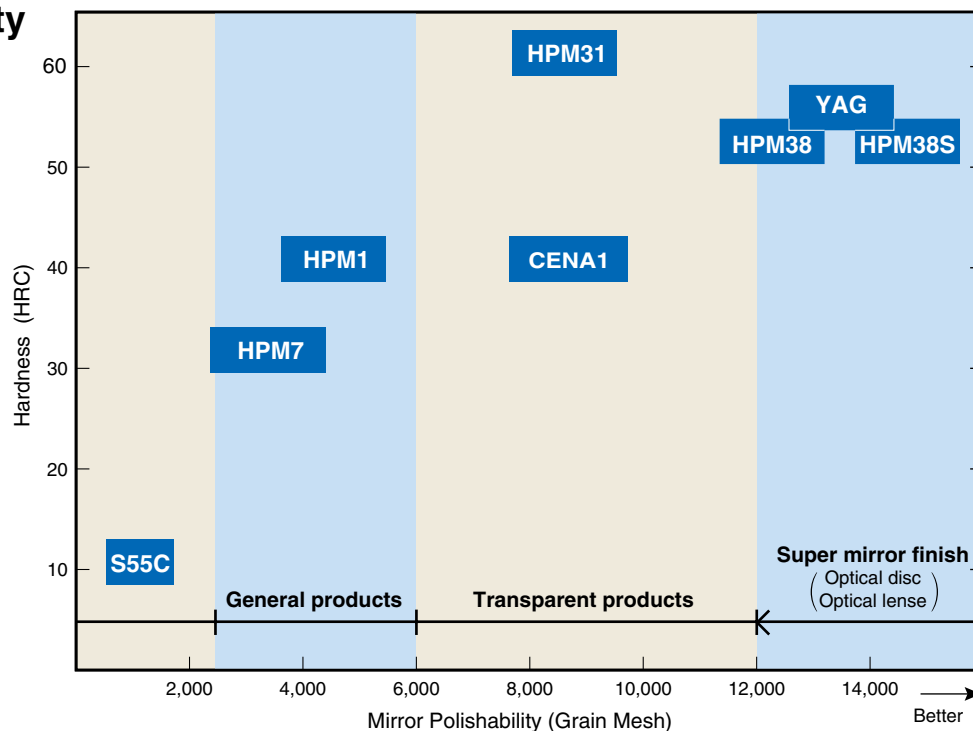
Feed: 0.15mm / rev

Depth: 30mm (brind hole)Dry



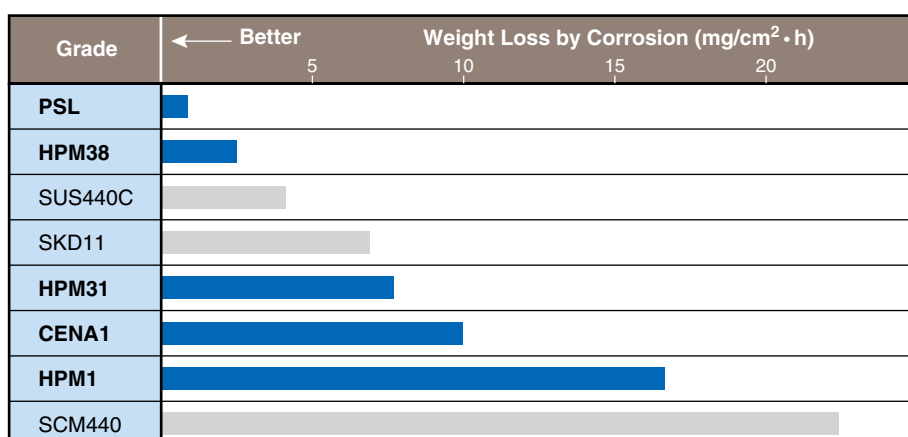
## Polishing Property

(Schematic Diagram)



## Corrosion Resistance

(5%Sulfuric Acid Solution)



# Properties Comparison

## Wear Resistance

Ohgoshi Wear Test

Work Material SMC415

Load 6.8kg

Total Friction Length 400m

Friction Speed 0.78m/sec

Grade	Hardness HRC	Wear Ratio (mm <sup>3</sup> /mm <sup>2</sup> • mm) x 10 <sup>-7</sup>	
		← Better	0.5 1.0
SKD12	59		
SKD11	60		
HPM31	59		
ZDP4	65		
SUS440C	57		
SKH51	63		
HAP10	64		

## Mechanical Properties

Grade	Hardness HRC	Tensile Strength N/mm <sup>2</sup>	0.2%Yield Strength N/mm <sup>2</sup>	Elongation %	Reduction of Area %
HPM7	32	975	855	20	55
HPM38	52	1,910	1,620	13	35
HPM77	32	990	845	16	41
PSL	39	1,170	1,100	11	34
CENA1	40	1,225	1,150	15	50
HPM1	40	L	1,225	18	40
		T	1,215	10	25
HPM75	42	1,305	1,110	11	28
YAG	53	2,010	1,910	10	48

## Physical Properties

Grade	Thermal Expantion Coef. ( x 10 <sup>-6</sup> °C)				Thermal Conductivity (W/m • K)				
	100°C	200°C	300°C	400°C	20°C	100°C	200°C	300°C	400°C
HPM7	11.6	12.2	12.8	13.4	34.3	38.3	39.8	40.4	40.6
HPM38	10.4	11.1	11.5	11.8	22.1	25.5	26.7	28.5	29.6
HPM77	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
HPM1	11.4	11.8	12.3	12.8	31.5	36.6	38.4	39.4	40.1
HPM31	12.4	13.1	13.6	14.1	22.1	25.5	26.7	28.5	30.0
HAP10	10.6	10.8	11.1	11.4	19.2	20.0	20.9	21.3	22.5
HPM75	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

# Resin Types and Grade Selection

Resin		Required Life and Grade Recommended				
		Required Properties for Mold	SHORT < 10 milliom	MEDIUM < 50 milliom	LONG < 100 milliom	MASS PRODUCTION > 100 milliom
Thermo-plastic	General	Machinability	HPM7	HPM7	CENA1 HPM1 FDAC	CENA1 FDAC ) + Nitriding
	Engineering Resin	Wear Resistivity	HPM7	HPM7+ Nitriding	CENA1 FDAC ) + Nitriding	HPM38 HPM31
	Reinforced	High Wear Resistivity	FDAC CENA1 HPM1	CENA1 FDAC ) + Nitriding, Plating	HPM31	ZDP4 HAP10
	Flame Retardant	Corrosion Resistivity	HPM38 CENA1	HPM38 PSL	HPM38	HPM38 + Plating
	Transparent	Mirror Polishability	CENA1	CENA1 HPM38	HPM38	HPM38
Thermo-set	eneral	Wear Resistivity	CENA1 HPM1 FDAC	CENA1 HPM1, FDAC ) + Plating	HPM31	HPM38
	Reinforced	High Wear Resistivity	CENA1 FDAC ) + Nitriding	HPM31	HPM31 + Plating	HAP10 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.

# 40HRC Prehardened Grade

**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 nitriding hardenability and can be used for wear resisting application.

## Application

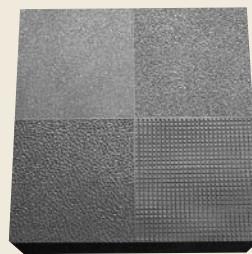
- Critical surface finish mold for transparent parts, etc.
- Engineering resin products.



Mobile Telephone



Video Camera



Creping Sample



Non-glare  
Treatment Sample



EDM Sample  
CENA1 100X100X50 (mm)

# 40HRC Prehardened Grade

## HPM1

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

HPM1 is free machining plastic mold steel prehardened to 40HRC . With superb machinability, HPM1 is fitted for general applications.

### Features

- No heat treatment is necessary. (37~41HRC)
- Excellent machinability among 40HRC prehardened grades.
- Uniform hardness even in large crosssection and less wear of parting.

### Application

- General plastic products.
- Home electronics, auto parts.
- Daily goods for mass production.
- Precision mold for rubber.
- High hardness die plate, holders.

## FDAC

Prehardened: 38~42HRC  
Free Machining  
Hot Working Die Steel

### Features

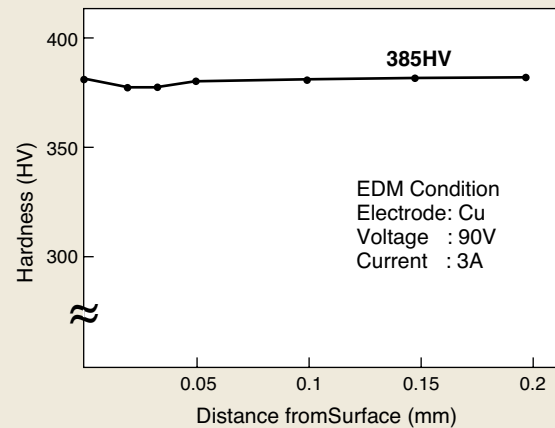
- No heat treatment is necessary. (38~42HRC)
- High wear resistance and toughness.
- High abrasion resistance.
- High hardness obtained by nitriding.

### Application

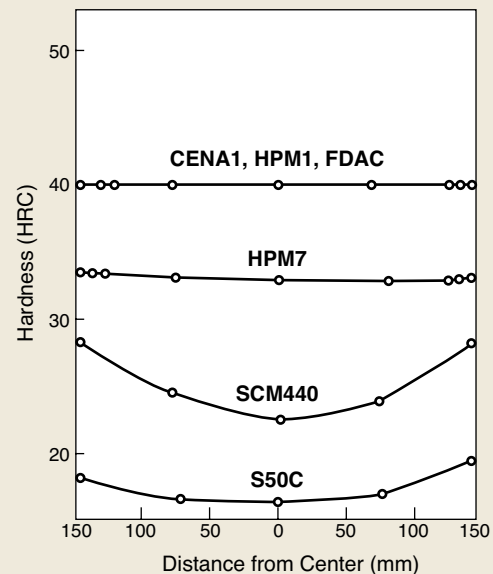
- Slide parts, Pin.
- Engineering resin products.



Personal Computer



Hardness Distribution of EDMachined Surface in Depth (HPM1)



Cross Section Hardness Distribution  
(300mm Square Size)

# 32HRC Prehardened Grade

## HPM7

Prehardened: 29~33HRC  
For Medium and Large Mold  
for General Application

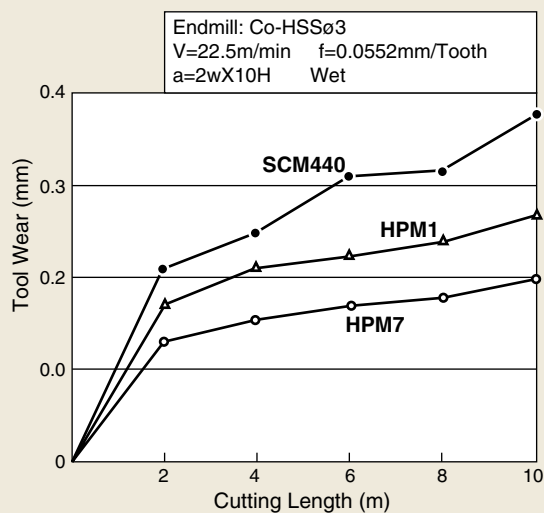
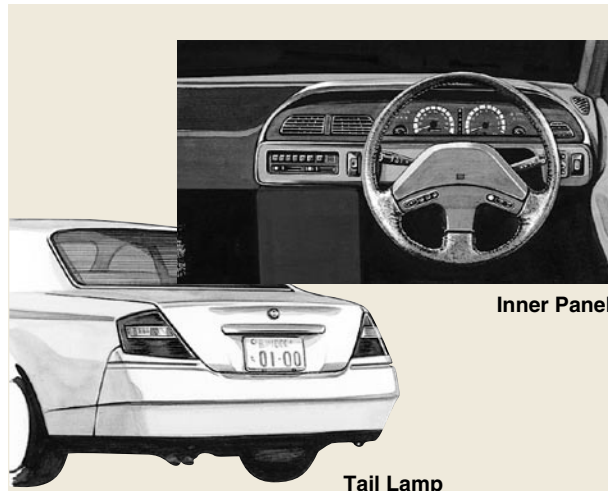
HPM7 is plastic mold steel prehardened to 29~33HRC fitted for medium and large size mold, having good machinability and weldability. In addition, it has good mirror polishability and EDMachinability to make itself one of the best steel among P20 improved grades.

## Features

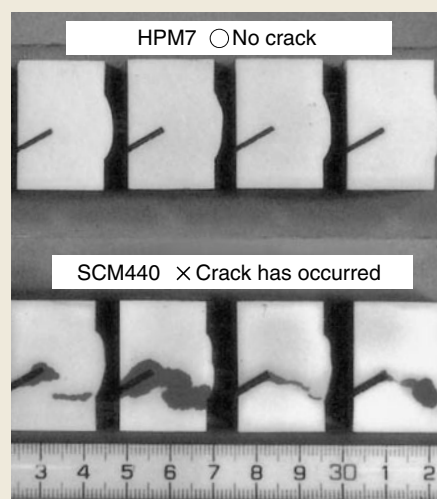
- Uniform hardness distribution even in large crosssection. (29-33HRC)
- Machinability is better than P20 or free machining carbon steel.
- Excellent weldability with least hardness elevation.
- Good mirror polishability.
- Less streak texture and least hardness elevation on EDM surface makes finishing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



Machinability Comparison



y-groove Weld Crack Test

JIS Z 3158

TIG Welding

No pre-heating / No post-heating

# Prehardened Stainless Grade

## HPM38

Prehardened: 29~33HRC  
Hardenable to: 50~55HRC  
For Anti-Corrosion and Mirror  
Polish Mold

HPM38 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 HPM38 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

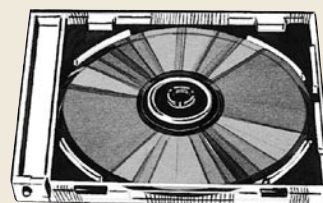
- Quenching: 1,000~1,050°C Air Cooling.
- Tempering: 200~500°C Air Cooling.

## HPM38S

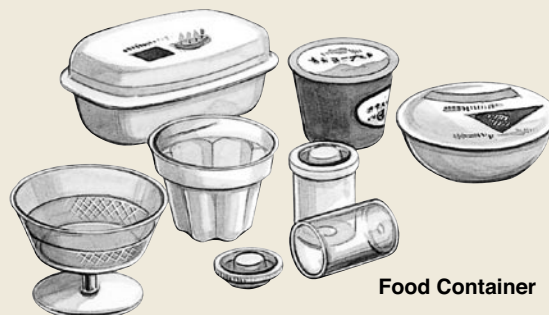
Prehardened: 29~33HRC  
Hardenable to: 50~55HRC  
For Super Mirror Polish  
Mold

### Features

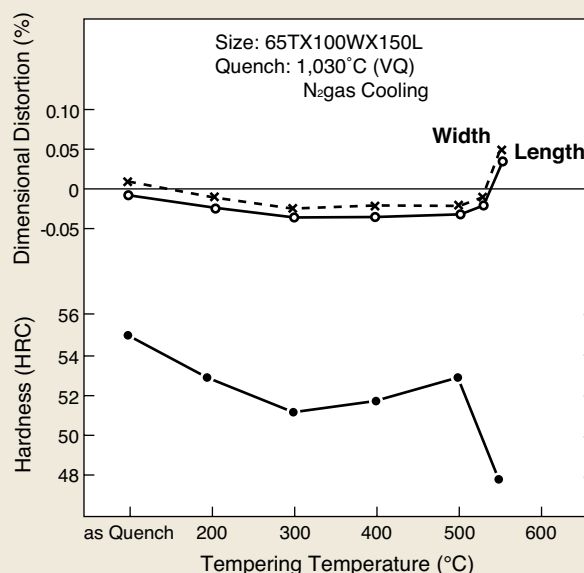
- Superior mirror polishability to below  $0.01\mu\text{m}$  surface roughness.
- Other features are same as HPM38.
- CD, DVD, MO, and optical lense.



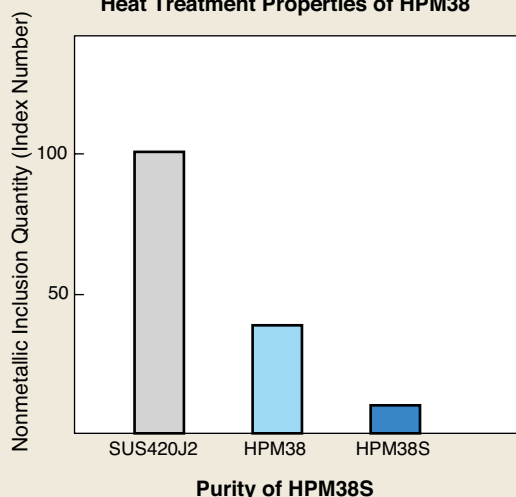
CD, DVD



Food Container



Heat Treatment Properties of HPM38



## 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

### HPM77

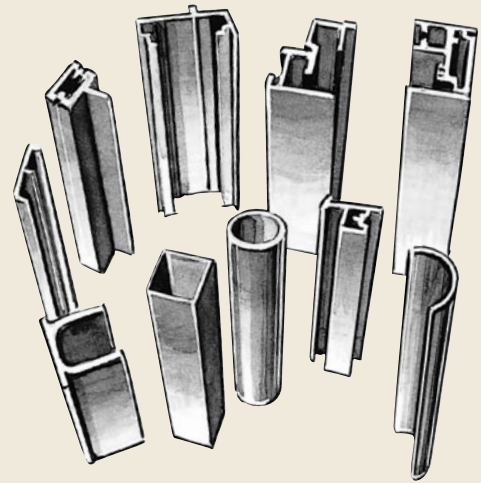
Prehardened : 29~33HRC  
Free Machining Martensitic  
Stainless Grade for Mold  
Base

### Features

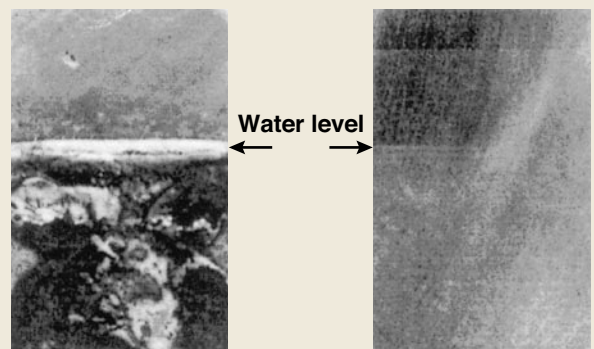
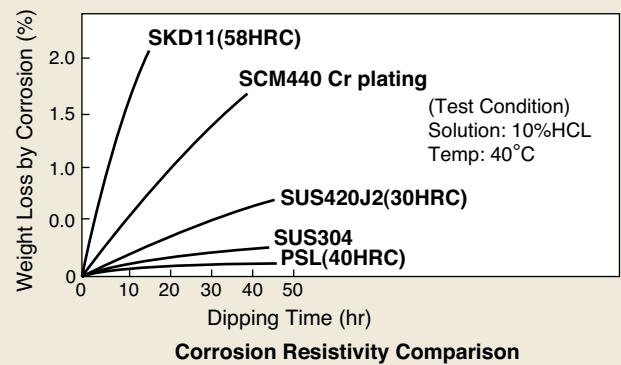
- Good corrosion resistance and well fitted for rust protection of water cooling holes or surface of mold base.
- Excellent machinability
- Prehardened and good mechanical properties

### 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



PVC Extruded Products



S55C

HPM77

Rust after 1 month dipping in water

# High Wear Resistance Grade

## HPM31

Hardenable to: 55~60HRC  
High Wear Resistant Grade  
for Mass Production

HPM31 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

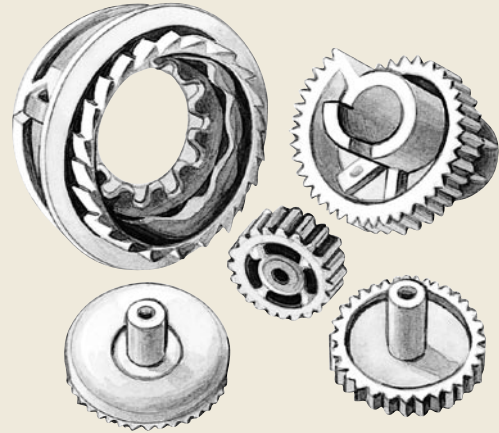
- High wear resistance as same as D2.
- Much better machinability and grindability than D2.
- Least heat treatment deformation, best fitted for precise mold.
- Good mirror polishability, crepe- and EDM finishability
- High hardness and toughness.

### Application

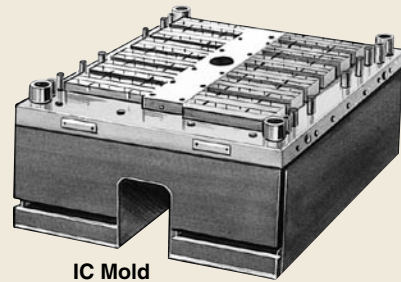
- Engineering resin products and thermosetting resin products.
- Precise mold: IC mold, Connector, Watch parts, Camera parts.

### Heat Treatment

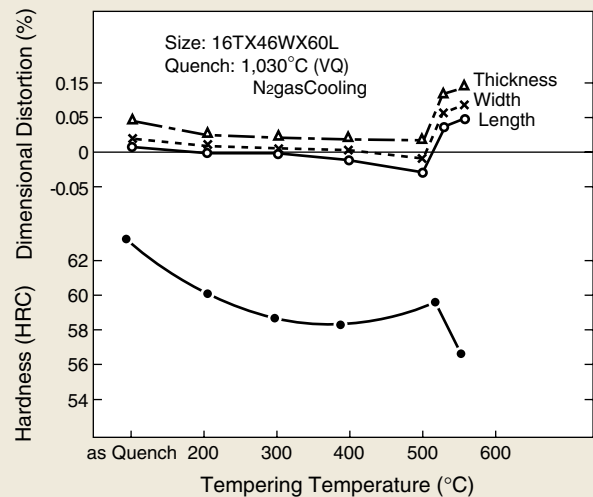
- Quenching: 1,000~1,050°C Air Cooling.
- Tempering: 200~550°C Air Cooling.



Engineering Resin Gear



IC Mold



Heat Treatment Properties of HPM31

## Aging Grade

### YAG

Hardenable to: 50~57HRC  
Super High Toughness  
Maraging Steel

As YAG is delivered as solution heat treated condition, you are advised to conduct aging at 480-520°C in order to get hardness between 50-57HRC after engraving cavity.

### Features

- Superior toughness and mechanical properties under high hardness and best fitted against breakage.
- Super mirror polishability.
- Hardness about 55HRC is obtainable by aging at 480°C with least distortion.

### Application

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

### HPM75

Hardenable to: 40~45HRC  
Non-Magnetic High  
Hardness Free Machining  
Plastic Mold Steel

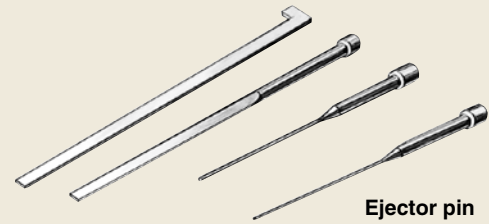
### Features

- Permeability ( $\mu$ ) is 1.01, equally non-magnetic as 304.
- 40-45HRC is obtainable by aging of 700°CX5h and has higher wear resistance.
- Good nitriding properties.

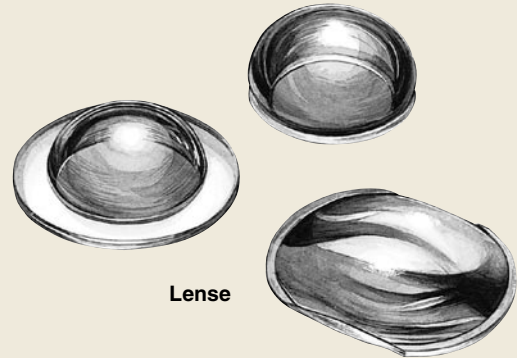
Remarks:  
Slower machining recommended as it is easily hardened by machining.

### Application

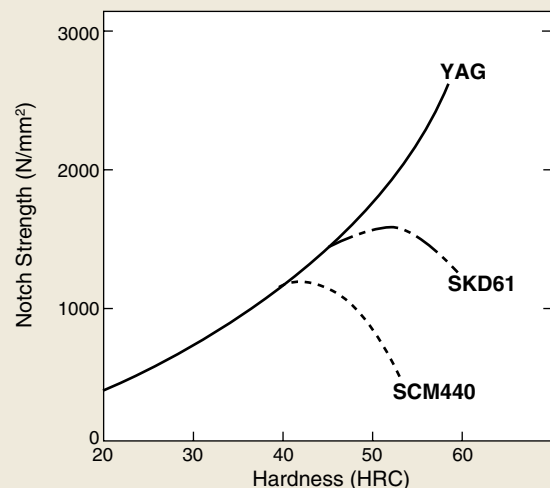
- Plastic magnet.
- Wear resistant, non-magnetic supportive tools.



Ejector pin



Lense



Relationship between Hardness and Notched Tensile Strength



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 scratch 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. Don't use alumina and chromium oxide for finishing as the polish capabilities are lower than diamond.
6. During long interruption, the object must be protected from the rust.

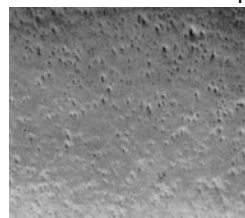
### Remarks:

A. For superior polishing use diamond compound.

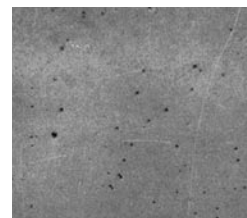
Don't use alumina nor chromium-oxide compound.



Diamond Compound Finish



Aluminium Oxide Finish Not Good



Chromium Oxide Finish Not Good

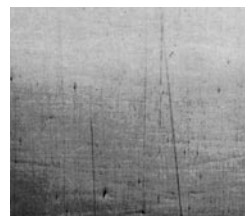
B. Load for polishing should be kept lowest possible.

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 inappropriate 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.

#### 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 HPM1, use welding rod made from HPM1-W.  
 Likewise, in case of TIG welding there are T-HTM-31 and T-HTM-38 in the market for welding for mold made from HPM31 and HPM38.
- B. In case of using coated electrode, mold should be dried by heating to 250-300°C.
- C. For cavity welding, TIG welding should be applied.  
 (TIG: Tungsten Inert Gas)

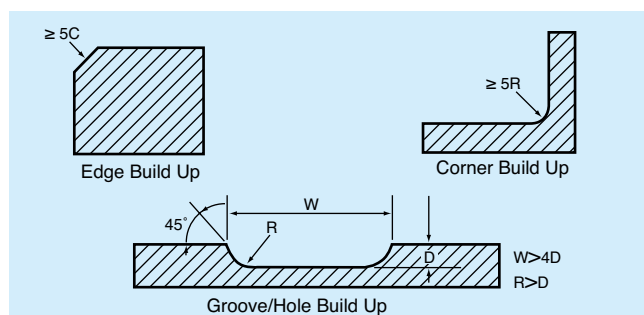


Figure 1. Standing shapes for build up welding

### 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.

Welding Rod Grade	Welding	Rod	Condition	Heat Cycle
CENA1	TIG	CENA1-W	• TIG Welding Rod { 2.4 φ ..... 80~160A { 3.2 φ ..... 110~200A Flow Rate 10~15ℓ/min	Pre-heat 200~400°C Welding Post-heat 200~400°C Cool Slowly Tempering 450~550°C (1hr/25mm) Air Cooling
HPM7	TIG	HPM7-W	• Shielded Metal Ark Welding Rod { 3.2 φ ..... 90~120A { 4.0 φ ..... 130~160A	Pre-heat 100~150°C Welding Post-heat 200~300°C Cool Slowly Tempering 500~600°C (1hr/25mm) Air Cooling
	Shielded Metal Ark	TH50		

Figure2. Welding procedure

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