YSS Advanced Plastic Mold Steel

CENA™-V

40 HRC Prehardened Grade Steel

This steel contributes to total cost reduction with good rust resistivity and excellent mirror polishability.

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• Please contact representatives of our Specialty Steel Division at the locations listed below for any inquiries.

Our address and contact indicated in this catalog are those as of June 2016.
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Tel: +81-3-6774-3001

Notes about safety

Steel is heavy. Please execute the safety measures to prevent falling or collapse of cargo or sandwiched during transportation or warehousing. Please ensure the safety of workers use the jigs and various protective equipment and follow the applicable laws and ministerial ordinance, ordinances, guidelines, etc. when sawing, cutting, heat treatment, polishing or when using as mould, machine parts, or tooling.

Catalog No.: HL-Y70 (PDF)
The plastic mold steel, CENA-V, was created to satisfy mold makers and resin product manufacturers. Its properties will reduce maintenance man-hours and prevent issues during mold manufacturing.

The steel contributes to productivity and total cost reduction with good rust resistivity and excellent mirror polishability.

**Characteristics Comparison**

<table>
<thead>
<tr>
<th>Item</th>
<th>CENA-V</th>
<th>CENA1 P21 conventional steel</th>
<th>HI-PM 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durability</td>
<td>35-41</td>
<td>37-42</td>
<td>37-43</td>
</tr>
<tr>
<td>Hardness (HRC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toughness</td>
<td>A</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Rust Resistivity</td>
<td>A</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>Mirror Polishability</td>
<td>A</td>
<td>A</td>
<td>A D</td>
</tr>
<tr>
<td>Weldability</td>
<td>A</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>B</td>
<td>C</td>
<td>B A</td>
</tr>
<tr>
<td>Machinability</td>
<td></td>
<td>Profiling</td>
<td>B A</td>
</tr>
<tr>
<td>Hole processing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Comparison with P21 conventional steel (Hitachi Metals product name: HI-PM-PRO)

**Examples for Application**

This mold steel can be utilized in a variety of applications, including home appliances, automotive parts, and bathroom fixtures.

- **Automotive lamp parts**: P21 conventional steel (40 HRC)
  - Properties of Evaluation: Polishability, Rust resistivity
  - Appearance: Applicable for large size mold

- **Bathroom fixtures**: P21 conventional steel (40 HRC)
  - Properties of Evaluation: Polishability, Rust resistivity
  - Appearance: Applicable for large size mold

- **Home appliances**: CENA1 (40 HRC)
  - Properties of Evaluation: Polishability, Rust resistivity
  - Appearance: Applicable for High-speed heat cycle molding

- **Home appliances**: P21 conventional steel (40 HRC)
  - Properties of Evaluation: Polishability
  - Appearance: Toughness
Customer Feedback on the Performance of CENA-V

Die makers and surface treaters had the following comments:

- CENA-V has high toughness and good cracking resistance which give it good weldability.
- CENA-V is easy to polish and has a glossy finish after polishing.
- CENA-V is suitable for exported molds thanks to its rust resistance.
- CENA-V can be used for slide cores because surface hardness after nitriding is over 1000HV.
- The process of surface texturing can be done more efficiently on CENA-V due to its resistance to rust.
- CENA-V exhibits an even surface texture with good rust resistance.

Mold Manufacturers had the following comments:

- CENA-V is a good choice for food container molds because of its resistance to rusting.
- CENA-V is less prone to clogging of water cooling holes.
- Cavity sections in CENA-V blocks are easier to maintain because of its rust resistivity.
- CENA-V molds can be produced in locations near the sea-side without concerns of corrosion.
- CENA-V’s high toughness results in less breakage of thin ribs during machining.
- CENA-V’s resistance to rust allows for smaller quantities of anti-rust oil to be needed.
- CENA-V has given us more freedom in designing integrated molds, because thick sections are available.

Rust Resistivity

CENA-V has improved rust resistivity compared to conventional pre-hardened P21.

Resistance to Stress Corrosion Cracking

CENA-V has improved stress corrosion cracking resistance compared to SUS420J2 improvement steel.
Texturing Processability

CENA-V’s homogenized microstructure provides good Texturing Processability.

<table>
<thead>
<tr>
<th>Texturing example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pear skin Finish</td>
</tr>
<tr>
<td>Grain Leather Pattern</td>
</tr>
<tr>
<td>Dot Pattern</td>
</tr>
<tr>
<td>Carbon Fiber Pattern</td>
</tr>
</tbody>
</table>

Mirror Polishability

CENA-V’s low inclusion content provides excellent Mirror Polishability.

<table>
<thead>
<tr>
<th></th>
<th>CENA-V</th>
<th>CENA1</th>
<th>P21 conventional steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>3μm diamond polishing (#8000)</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Examples Interference figure comparison of #8000 mirror polished surface.

<Attention>
Mirror polished surfaces above #5000 will strongly depend on skill level. Quality of Mirror surface may be worsened by the polishing skill level.

Polishing Procedure

- Polish by oil grinding stone (use an oil-based coolant)
  - #400 → #600 → #1000 → #1500 → #3000
- Polish by coated abrasive (Dry process)
  - #1500 → #2000 → #2500
- Finish polishing by diamond paste
  - #1500 (9 μm) → #3000 (6 μm) → #8000 (3 μm)

Key Points of Polishing Procedure (by our knowledge)

Point 1: When changing numbers, check if any scratches remain by rotating the polishing direction (45-90 degrees).
Point 2: Check for remaining scratches by illuminating the polished surface and inspecting in multiple directions.
Point 3: When changing numbers, wash and remove all polishing grains.
Point 4: When using an oil whetstone, apply sufficient oil to prevent scratching.
Point 5: When using sandpaper, polish 10-15 times at once to prevent orange peel or clogging.
Point 6: Polishing with a diamond compound needs to be performed in short intervals. Excessive polish can produce pinholes or orange peel.
Point 7: For maximum polishing capability, use a diamond compound over alumina and chromium oxide.
Point 8: Protect the metal from rust during long interruptions in the polishing process.

Remarks:
A. Use a diamond compound over alumina and chromium oxide.
B. Polishing loads should be kept as low as possible.
C. Foregoing polish should be done prudently.
D. Rust proof measures must be taken in any interruption of jobs.
Nitriding

Nitriding can increase surface hardness up to 1000 HV, useful for sliding applications.

Hardness profile of gas soft nitriding cross section (example)

![Hardness profile](image)

Nitrided surface microstructure (example)

![Microstructure](image)

CENA-V is more resistant to corrosion from reinforced resin.

CENA-V is more resistant to abrasion caused by sliding friction.

Slurry Wear Test

- CENA-V 37 HRC
- P21 conventional steel 40 HRC

Ohgoshi-method Wear Test

- CENA-V 37 HRC
- P21 conventional steel 40 HRC

Wear Resistance

Hardness is lower than conventional P21, with equal or higher wear resistance.

Toughness

High impact toughness in comparison to conventional P21 makes CENA-V difficult to fracture.

Strength Properties

CENA-V has high percent elongation and reduction of area in comparison to conventional P21.

Weldability

High toughness improves crack resistance from welding build-up.

Welding condition

<table>
<thead>
<tr>
<th>Rod</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>φ2.4</td>
<td>80–160 A</td>
</tr>
<tr>
<td>φ3.2</td>
<td>110–200 A</td>
</tr>
</tbody>
</table>

Welding procedure diagram

- Pre-heat and Post-heat are recommended to prevent mold cracking.
- Stress relieving is recommended to prevent uneven polishing and texturing.

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Machinability

**Processing**

Machinability of high-feed cutting radius mill is better than conventional P21.

![Graph showing machinability comparison between P21 conventional steel and CENA-V](image)

**Finish processing**

Finish processing by coated carbide end mill is comparable to conventional P21. Ball end mill edge wear is equal or worse than conventional P21.

![Graph showing finish wear comparison between P21 conventional steel and CENA-V](image)

**Drilling processing**

The tool wear is worse than conventional P21.

![Graph showing drilling wear comparison between P21 conventional steel and CENA-V](image)

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**Physical Properties**

CENA-V's high thermal conductivity is comparable to conventional P21.

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal expansion coefficient (100-600°C)</th>
<th>Thermal conductivity (W/m·K)</th>
<th>Young's modules (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENA-V</td>
<td>10.6</td>
<td>20.5</td>
<td>205</td>
</tr>
<tr>
<td>CENA 1</td>
<td>10.8</td>
<td>20.5</td>
<td>205</td>
</tr>
<tr>
<td>P21</td>
<td>12.5</td>
<td>20.5</td>
<td>205</td>
</tr>
</tbody>
</table>

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**Wear comparisons: After drilling 1000 times**

Chip separation may be difficult due to high toughness. Hole drilling is advisable to about 70-85 percent compared to conventional P21.

![Graph showing wear comparison between P21 conventional steel and CENA-V](image)

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**Gun drill processing conditions**

<table>
<thead>
<tr>
<th>Material: General-purpose cemented carbide gun drill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diam.</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>6.0</td>
</tr>
<tr>
<td>8.0</td>
</tr>
<tr>
<td>10.0</td>
</tr>
<tr>
<td>14.0</td>
</tr>
<tr>
<td>18.0</td>
</tr>
<tr>
<td>20.0</td>
</tr>
<tr>
<td>22.0</td>
</tr>
</tbody>
</table>

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**HSS drill processing conditions**

Material: JIS-SKH51

<table>
<thead>
<tr>
<th>Diam.</th>
<th>Spindle speed (rev/min)</th>
<th>Feed (mm/min)</th>
<th>Cutting speed (m/min)</th>
<th>Feed (mm/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>800</td>
<td>40</td>
<td>12</td>
<td>0.050</td>
</tr>
<tr>
<td>6.0</td>
<td>500</td>
<td>30</td>
<td>10</td>
<td>0.056</td>
</tr>
<tr>
<td>8.0</td>
<td>400</td>
<td>40</td>
<td>10</td>
<td>0.080</td>
</tr>
<tr>
<td>10.0</td>
<td>320</td>
<td>26</td>
<td>10</td>
<td>0.080</td>
</tr>
<tr>
<td>12.0</td>
<td>270</td>
<td>22</td>
<td>10</td>
<td>0.100</td>
</tr>
<tr>
<td>15.0</td>
<td>210</td>
<td>21</td>
<td>10</td>
<td>0.119</td>
</tr>
<tr>
<td>20.0</td>
<td>160</td>
<td>19</td>
<td>10</td>
<td>0.145</td>
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</tbody>
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