Daido's Dream Series

Cold Forging Die Steel

High hard and tough high speed tool steel with excellent hardenability

Features

1. Applicable with the maximum hardness 66HRC
2. Fine carbides contribute higher toughness and fatigue strength than those of M651 equivalent to SKH51
3. Greater hardenability results in high performance even in large dies and gas quenching in vacuum furnace.
4. Double melting realizes clean and homogeneous steel with less non-metallic inclusions

Applications

- Cold forging dies and punches
- Cold work roll, emboss roll
- Tools quenched by gas in vacuum furnace

Microstructure (As annealed)

- Finely distributed coarse carbides

Durability of drilling tool

Nitridering

An example of micro structure nitried by PS process

- PS process
- Daido Amistar's originally developed process featured by high scuffing and erosion resistance

Physical Properties

- Coefficient of expansion

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>101</td>
<td>102</td>
<td>103</td>
<td>104</td>
<td>105</td>
<td>106</td>
<td>107</td>
</tr>
</tbody>
</table>

- Thermal conductivity

<table>
<thead>
<tr>
<th>Mpa × S/m</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>101</td>
<td>102</td>
<td>103</td>
<td>104</td>
<td>105</td>
<td>106</td>
<td>107</td>
</tr>
</tbody>
</table>

- Specific heat

<table>
<thead>
<tr>
<th>Specific heat (J/kg K)</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>101</td>
<td>102</td>
<td>103</td>
<td>104</td>
<td>105</td>
<td>106</td>
<td>107</td>
</tr>
</tbody>
</table>

- Young's modulus 210 Gpa

Applications

- Durability of drilling tool
- Nitridering

Applications

- Cold forging dies and punches
- Cold work roll, emboss roll
- Tools quenched by gas in vacuum furnace

Heat treatment

<table>
<thead>
<tr>
<th>Re-heating temperature</th>
<th>Heat treatment conditions (°C)</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annealing</td>
<td>Quenching</td>
<td>Tempering</td>
</tr>
</tbody>
</table>

- OQ: Oil quenching
- GC: Gas quenching
- AC: Air cooling

Microstructure (As annealed)

- finel distributed coarse carbides

Microstructure (As quenched)

- Finely distributed coarse carbides

Material properties

- High hard and tough high speed tool steel
- Excellent hardenability

Applications

- Cold forging dies and punches
- Cold work roll, emboss roll
- Tools quenched by gas in vacuum furnace

Heat treatment

- Annealing
- Quenching
- Tempering
- Annealed
- Softening
- Tempering
Characteristics

Tempering hardness

- Specimen: 15mm square
- Hardening: Oil quenching
- Tempering: Air cooling

Toughness: Charpy impact property

- Specimen: 10mm dia. Bar center
- Hardening: Oil quenching
- Tempering: Air cooling

Heat checking resistance

- Specimen: 15mm dia. 10 mm thick
- Heat Treatment: DRM3-1100°C, 0Q
- Test method: Induction heating 20~600°C (1000 times)

Fatigue strength

- Specimen: 15mm dia. 10 mm thick
- Heat Treatment: DRM3-1100°C, 0Q
- Test method: Rotating bending fatigue test (20°C)

Hot hardness

- Specimen: 15mm dia. Bar center
- Hardening: Oil quenching
- Tempering: Air cooling

Hardenability

- Specimen: 10mm dia. × 60 mm
- Hardening: 1140°C salt bath quenching

Dimensional changes in heat treatment

- Specimen: 10mm dia. × 60 mm
- Hardening: 1140°C salt bath quenching