

DRM2

Warm and Cold Forging Die Steel



High hard and tough matrix type high speed tool steel

Features

Matrix type high speed tool steel available for warm and cold forging tools where critical performance is required. DRM2 prolongs service life due to its higher hardness and toughness than those of conventional grades.

1. Applicable with the maximum hardness 62HRC
2. Fine microstructure contributes to high toughness and fatigue strength
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

- Warm forging dies and punches
- Cold forging dies and punches

Heat treatment

DRM2	Harden 1100C (2012F)	Draws (minimum of 2)	Maximum toughness	600C (1112F) HRC58	
	Recommend a minimum 6 barr quench		Good toughness & wear	580C (1076F) HRC60	
			Maximum wear	550C (1022F) HRC62	
	Heat treatment conditions (°C)			Hardness	
Re-forging Temperature	Annealing	Quenching	Tempering	Annealed	Hardening/Tempering

Requested to inquire

800~880 Slow cooling

1050~1120 OQ, GC, Salt bath

550~620 AC, \geq twice

\leq 235HB

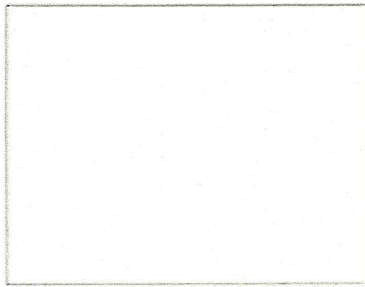
56~62HRC

OQ: Oil quenching, GC: Gas quenching in vacuum furnace, AC: Air cooling

Microstructure (As annealed)

Fine and uniform microstructure with less coarse carbides.

DRM2 (Middle of 100 dia. bar)

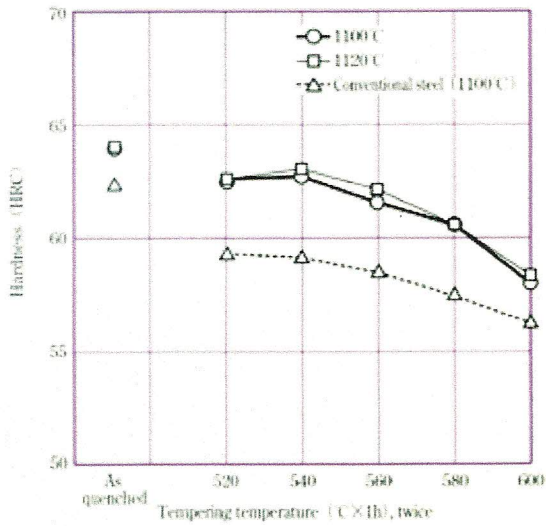


Conventional steel (Daido)



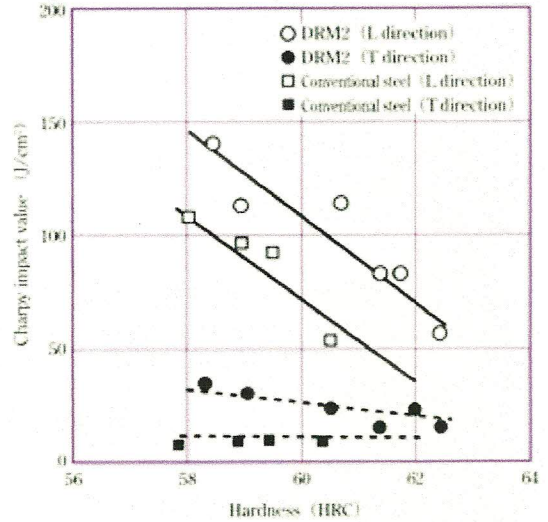
\langle Cr₂O₃ Electrically etching

Tempering hardness



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

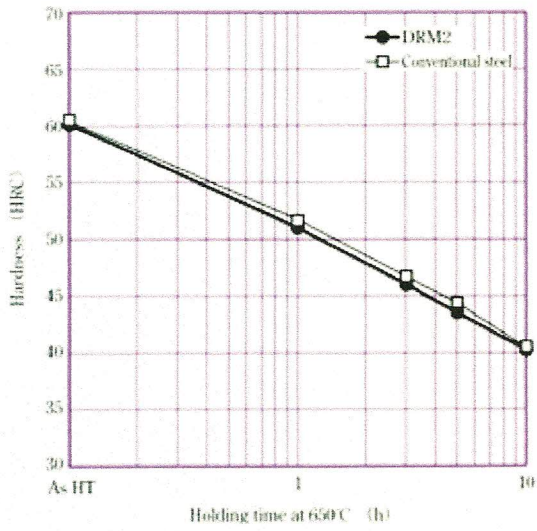
Toughness: Charpy impact property



- Sampling : 100mm dia. Bar center
- Specimen : 10R notched
- Heat treatment : DRM2 H : 1120°C OQ
T : 540~600°C AC, twice
Conventional Steel --- H : 1120°C OQ
T : 540~600°C AC, twice

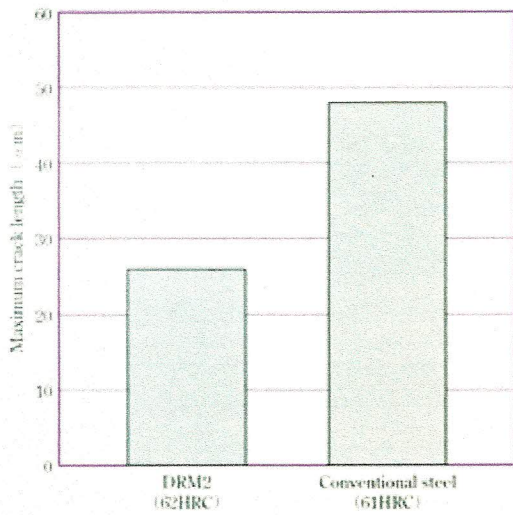
Temper softening resistance

Hot hardness



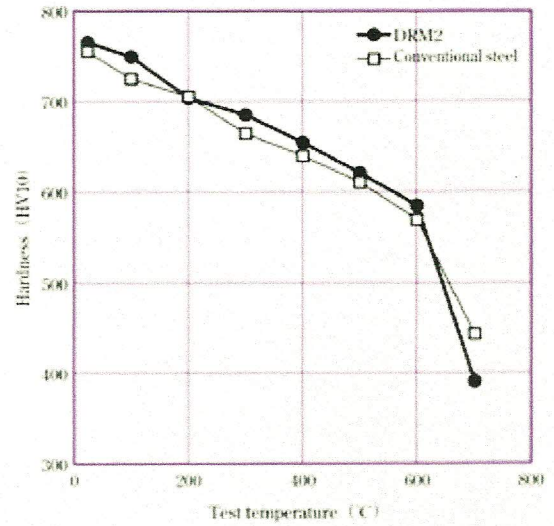
● Heat treatment : DRM2..... H : 1120°C OQ
 T : 580°C AC, twice
 Conventional Steel... H : 1120°C OQ
 T : 610°C AC, twice

Heat checking resistance



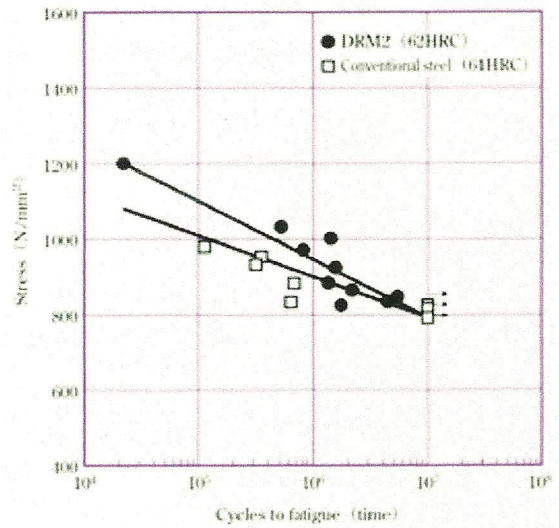
● Specimen : 15 mm dia, 10 mm thick
 ● Heat treatment : DRM2..... H : 1120°C OQ
 T : 560°C AC, twice
 Conventional Steel... H : 1140°C OQ
 T : 560°C AC, twice
 ● Test method : Induction heating 20 → 700°C (1000 times)

Hardenability



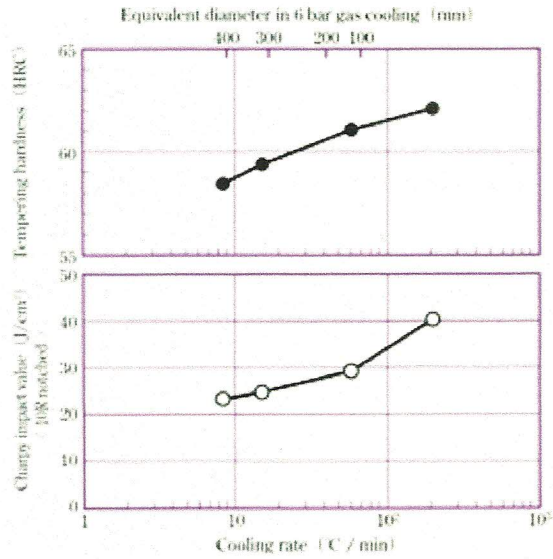
● Heat treatment : DRM2..... H : 1120°C OQ
 T : 560°C AC, twice
 Conventional Steel... H : 1120°C OQ
 T : 560°C AC, twice

Fatigue strength

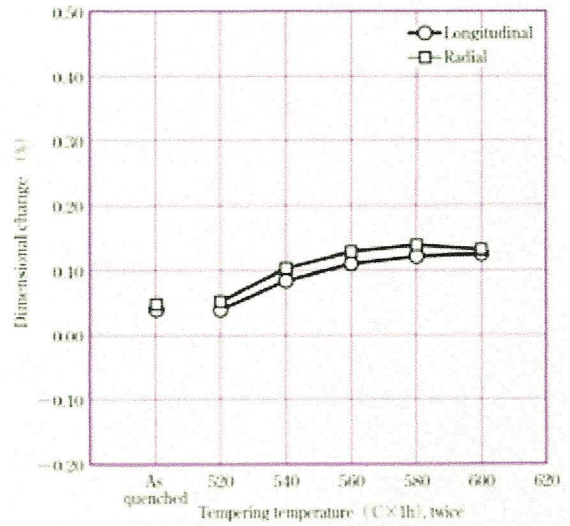


● Sampling : 100 mm dia. Bar center
 ● Heat treatment : DRM2..... H : 1120°C OQ
 T : 560°C AC, twice
 Conventional Steel... H : 1140°C OQ
 T : 560°C AC, twice
 ● Test method : Rotating bending fatigue test (20°C)

Dimensional changes in heat treatment

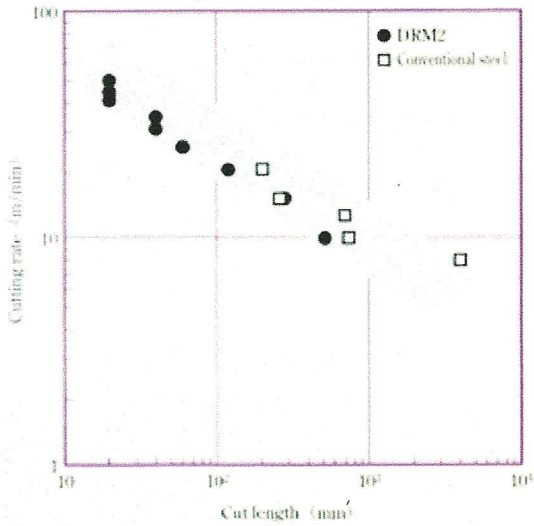


- Sampling : 100mm dia. Bar center
- Heat treatment : H : 1120°C (200°C/min → equal to OQ)
T : 560°C AC, twice



- Specimen : 36mm dia. × 60 mm
- Hardening : 1120°C salt bath quenching

Drilling machinability



- Specimen : As annealed
- Tool : NACHI SD φ5mm (non-coated)
- Test condition : Feed : 0.15mm/rev → Hole depth : 20mm
Cutting fluid : none

Physical Properties

◆ Coefficient of expansion

	20~100°C	20~200°C	20~300°C	20~400°C	20~500°C	20~600°C	20~700°C	20~800°C
×10 ⁻⁶ /K	11.0	11.4	11.8	12.1	12.3	12.6	12.4	12.9

◆ Thermal conductivity

	25°C	200°C	300°C	400°C	500°C	600°C	700°C
W/m·K	21.2	25.9	27.9	29.0	28.8	29.2	29.6
[cal/cm·sec]	[0.055]	[0.064]	[0.067]	[0.069]	[0.069]	[0.070]	[0.071]

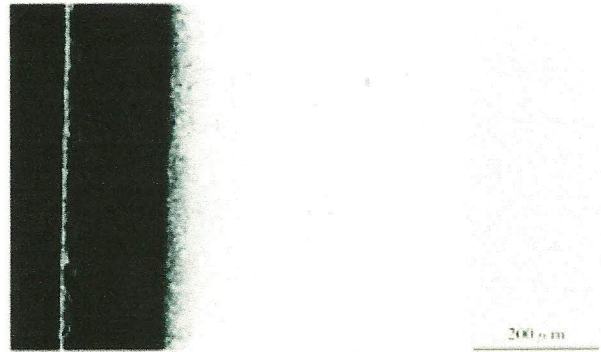
◆ Specific heat

	25°C	200°C	300°C	400°C	500°C	600°C	700°C
J/kg·K	458	518	555	598	659	756	910
[cal/g·°C]	[0.109]	[0.124]	[0.133]	[0.143]	[0.158]	[0.181]	[0.217]

◆ Young's modulus 210 GPa

Specimen condition : H : 1120°C DD T : 560°C AC twice

Nitriding



An example of micro structure nitrided by PS process

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

