

# Dream Series Daido's **DRM1**

## Hot and Warm Forging Die Steel

 High tough matrix type high speed tool steel

### Features

High hardness and high tough Matrix type high speed tool steel vastly surpassing hot work die steels. DRM1 improves hot and warm die life by its higher toughness than conventional grade.

- ① Applicable with the maximum hardness of 58HRC
- ② High hardness and tough grade with excellent heat checking resistance
- ③ Fine microstructure as that of hot work die steels resulting in higher toughness than conventional high speed tool steels
- ④ High softening resistance and hot hardness
- ⑤ Double melting realizes clean and homogeneous steel with less non-metallic inclusions

### Applications

- Hot forging dies and punches
- Warm forging dies and punches

### Heat treatment

Re-forging Temperature	Heat treatment conditions (°C)			Hardness	
	Annealing	Quenching	Tempering	Annealed	Hardening / Tempering
Requested to inquire	800~880 Slow cooling	1100~1140 OQ, GC, Salt bath	550~620 AC, ≥twice	≤235HB	56~58HRC

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

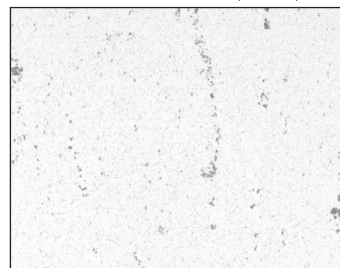
### Microstructure (As annealed)

- Fine and uniform microstructure with less coarse carbides

DRM1 (Middle of 100 dia bar)



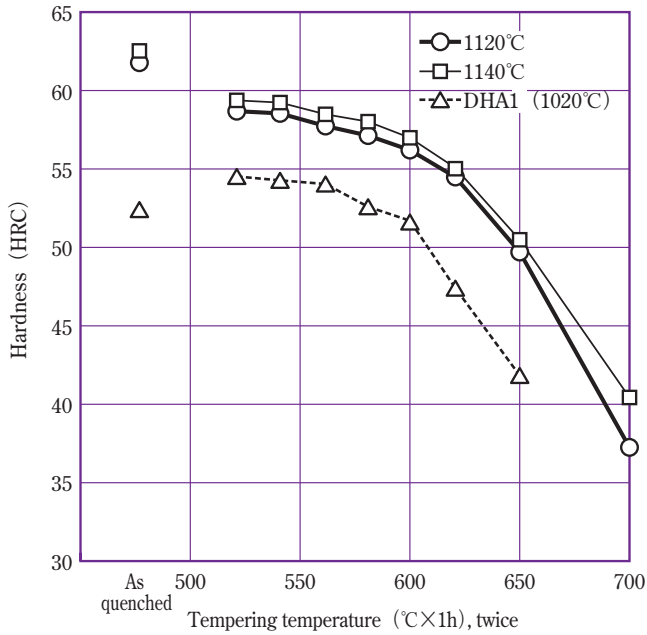
Conventional steel (Daido)



⟨Cr<sub>2</sub>O<sub>3</sub> Eletrically etching⟩

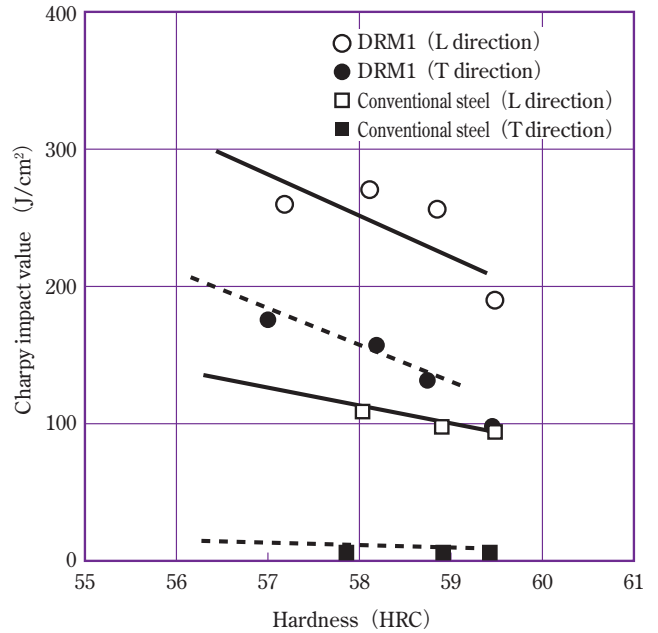
# Characteristics

## Tempering hardness



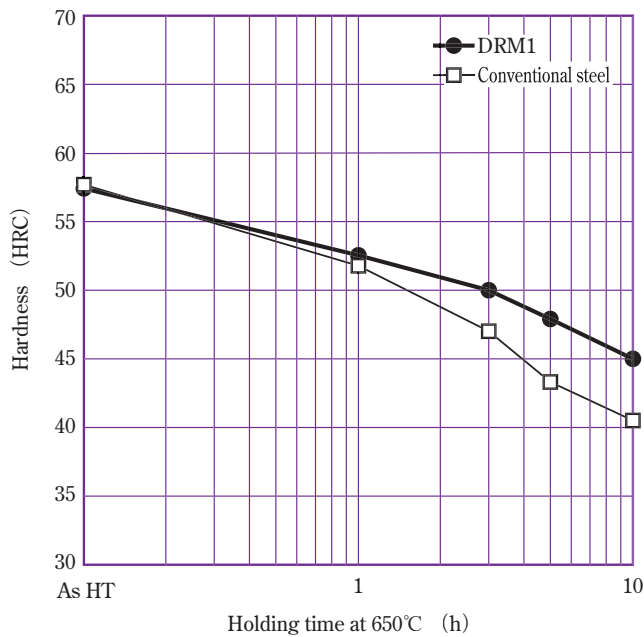
- Specimen : 15mm square
- Hardening : Oil quenching
- Tempering : Air cooling

## Toughness : Charpy impact property



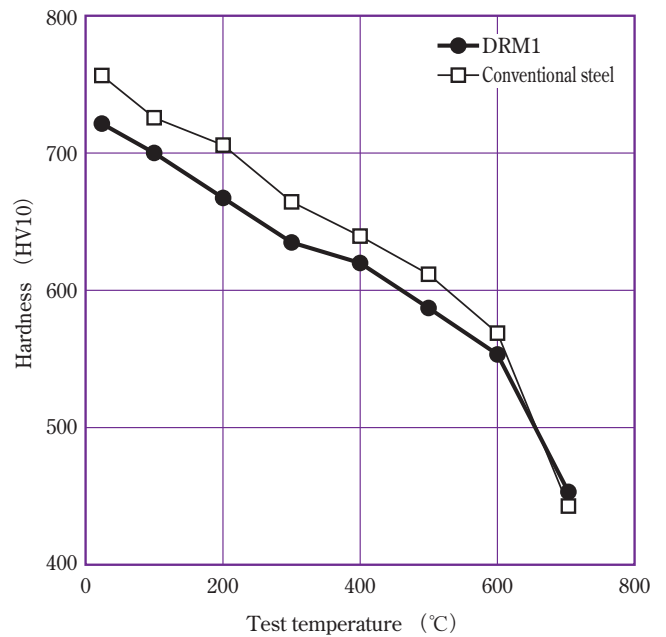
- Sampling : 100mm dia. Bar center
- Specimen : 10R notched
- Heat treatment : DRM1..... H : 1140°C OQ  
T : 540~600°C AC, twice  
Conventional Steel ... H : 1120°C OQ  
T : 540~600°C AC, twice

## Temper softening resistance



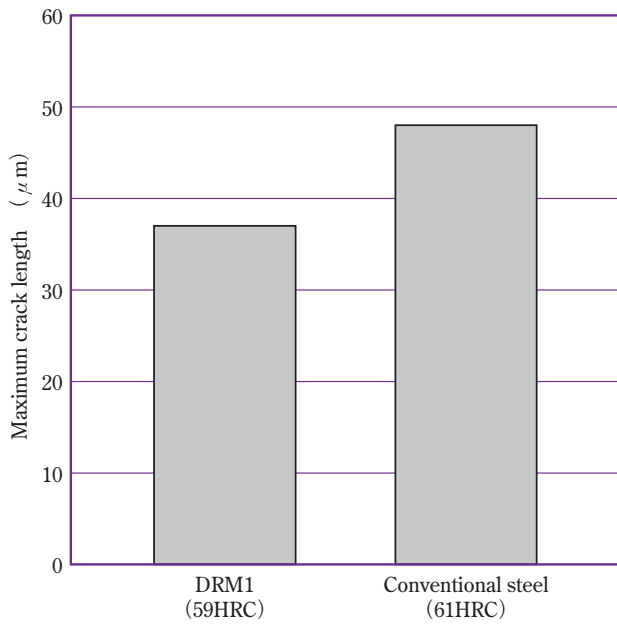
- Heat treatment : DRM1..... H : 1140°C OQ  
T : 600°C AC, twice  
Conventional Steel ... H : 1120°C OQ  
T : 610°C AC, twice

## Hot hardness



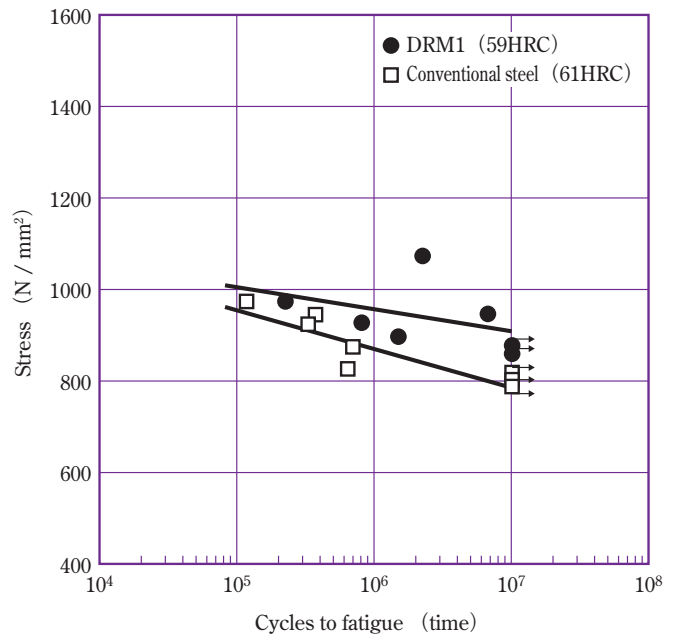
- Heat treatment : DRM1..... H : 1140°C OQ  
T : 560°C AC, twice  
Conventional Steel ... H : 1140°C OQ  
T : 560°C AC, twice

## Heat checking resistance



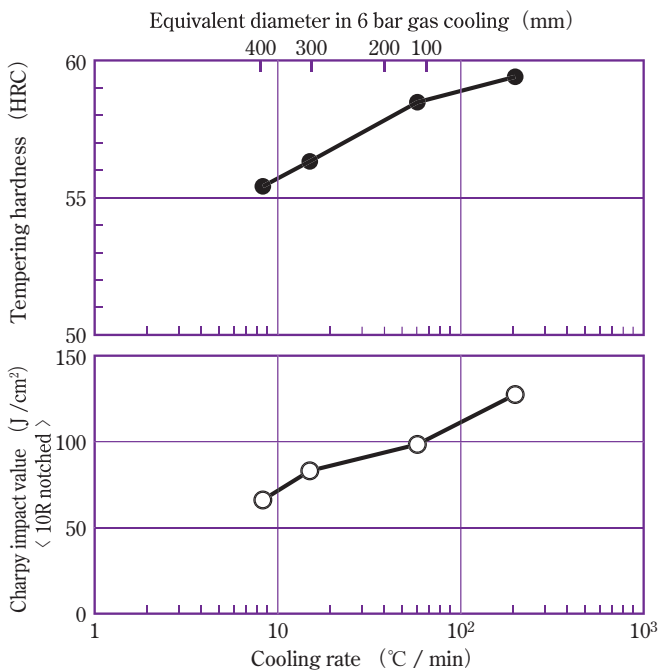
- Specimen : 15 mm dia. 10 mm thick
- Heat treatment : DRM1 ..... H : 1140°C OQ  
T : 560°C AC, twice  
Conventional Steel ... H : 1140°C OQ  
T : 560°C AC, twice
- Test method : Induction heating 20 ↔ 700°C (1000 times)

## Fatigue strength



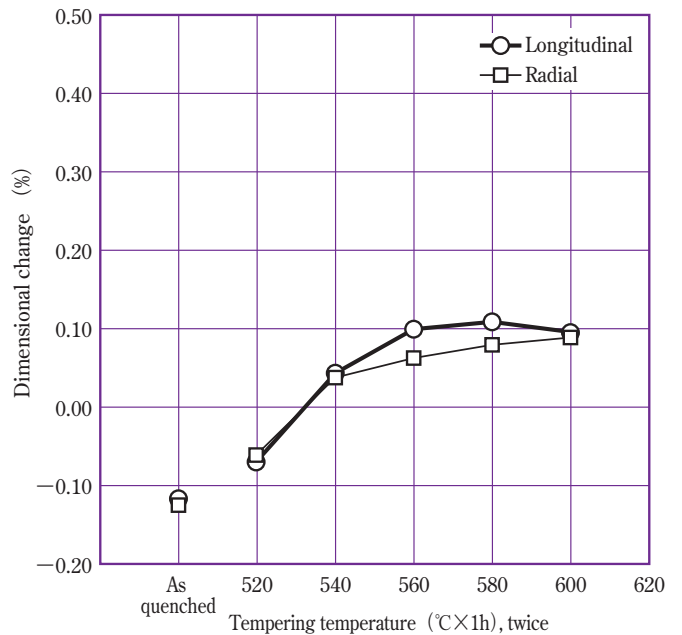
- Sampling : 100 mm dia. Bar center
- Heat treatment : DRM1 ..... H : 1140°C OQ  
T : 560°C AC, twice  
Conventional Steel ... H : 1140°C OQ  
T : 560°C AC, twice
- Test method : Rotating bending fatigue test (20°C)

## Hardenability



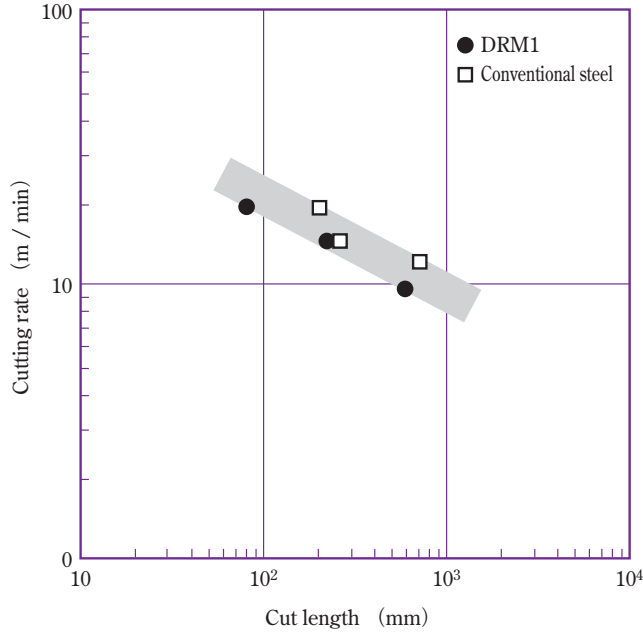
- Sampling : 100mm dia. Bar center
- Heat treatment : H : 1140°C (200°C / min → equal to OQ)  
T : 560°C AC, twice

## Dimensional changes in heat treatment



- Specimen : 100mm dia. × 60 mm
- Hardening : 1140°C salt bath quenching

## Drilling machinability



- Specimen : As annealed
- Tool : NACHI SD  $\phi$  5mm (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
$\times 10^{-6}/K$	11.2	11.4	11.7	11.9	12.2	12.4	12.7	12.3

### ◆ Thermal conductivity

	25°C	200°C	300°C	400°C	500°C	600°C	700°C
W/m·K	22.4	26.3	27.3	28.6	28.4	29.1	28.8
[cal/cm·sec·°C]	[0.054]	[0.063]	[0.065]	[0.068]	[0.068]	[0.070]	[0.069]

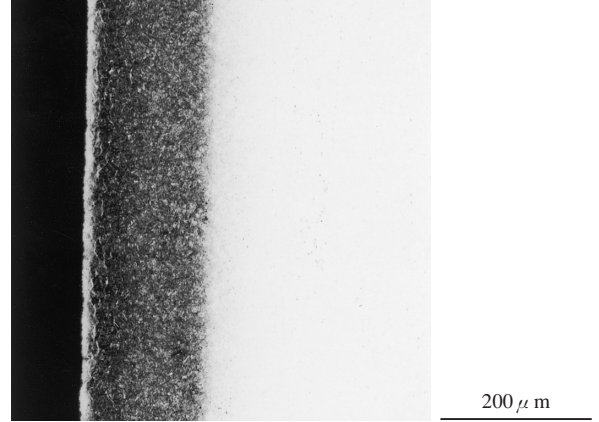
### ◆ Specific heat

	25°C	200°C	300°C	400°C	500°C	600°C	700°C
J/kg·K	413	487	519	562	616	705	840
[cal/g·°C]	[0.099]	[0.116]	[0.124]	[0.134]	[0.147]	[0.168]	[0.201]

### ◆ Young's modulus 210 Gpa

· Specimen condition : H : 1140°C OQ T : 560°C AC twice

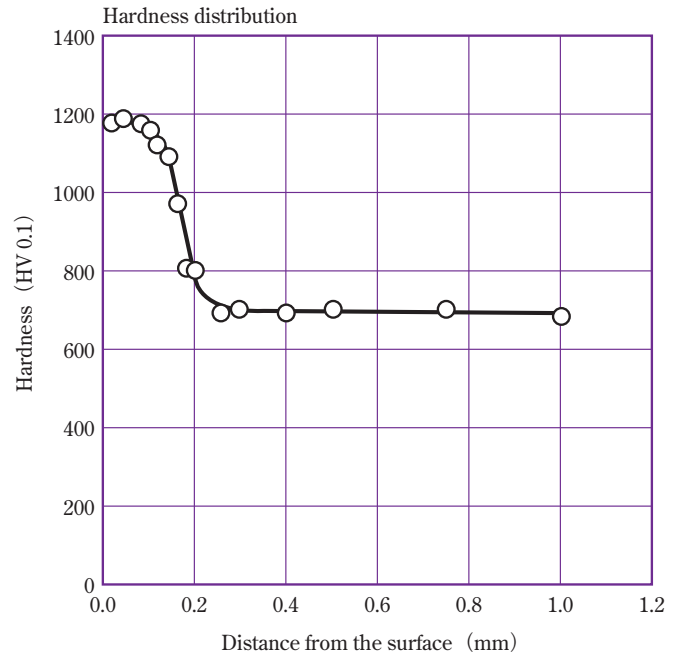
## Nitriding



An example of micro structure nitrided by PS process

### ● PS process

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



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