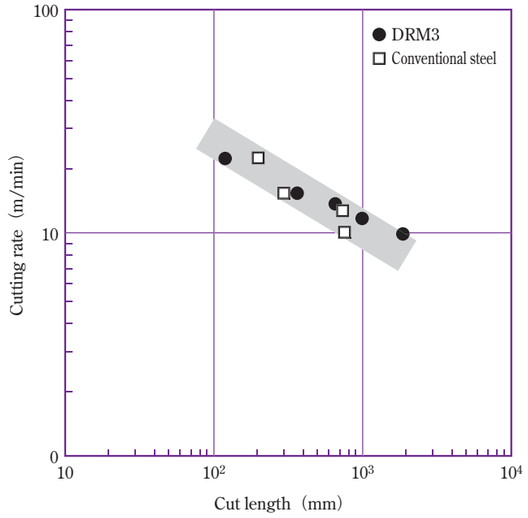
Durability of drilling tool



●Specimen ：As annealed
●Tool ：NACHI SD ϕ 5mm（non-coated）
●Test condition ・Feed：0.15mm/rev ・Hole depth：20mm
・Cutting fluid：none

Physical Properties

◆Coefficient of expansion

	20～100℃	20～200℃	20～300℃	20～400℃	20～500℃	20～600℃
×10⁻⁶/K	11.1	11.5	11.9	12.2	12.4	12.7

◆Thermal conductivity

	25℃	200℃	300℃	400℃	500℃	600℃	700℃
W/m·K [cal/cm·sec·℃]	18.0 [0.043]	21.5 [0.051]	23.1 [0.055]	24.2 [0.058]	24.4 [0.058]	25.2 [0.060]	26.0 [0.062]

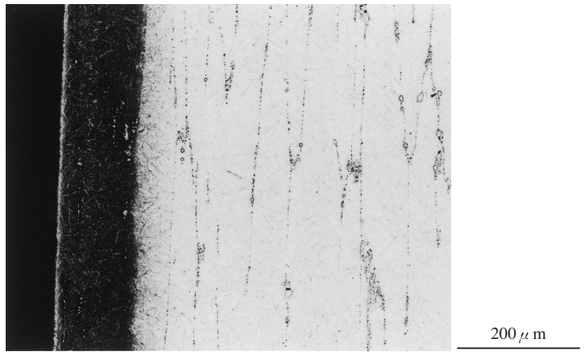
◆Specific heat

	25℃	200℃	300℃	400℃	500℃	600℃	700℃
J/kg·K [cal/g·℃]	424 [0.101]	480 [0.115]	520 [0.124]	560 [0.134]	612 [0.146]	698 [0.167]	830 [0.198]

◆Young's modulus 210 Gpa

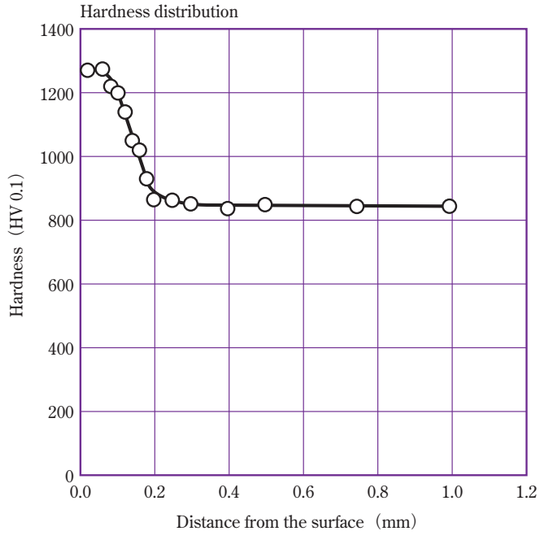
・Specimen condition : H : 1140℃ OQ T : 560℃ AC twice

Nitriding



An example of micro structure nitrided by PS process
●PS process
・Daido Amistar's originally developed process featured by high scuffing and errosion resistance

Hardness distribution



DAIDO STEEL

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www.daido.co.jp

SS0409
16.03.0,5（RC）

Dream Series

Daido's DRM3

Cold Forging Die Steel

High hard and tough high speed tool steel with excellent hardenability

Features

Conventional grade MH88 has been improved to DRM3. High hardness and tough DRM3 with excellent hardenability is suitable for high precision cold working tools.

①Applicable with the maximum hardness 66HRC
②Fine carbides contribute higher toughness and fatigue strength than those of MH51 equivalent to SKH51
③Greater hardenability results in high performance even in large dies and gas quenching in vacuum furnace.
④Double 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

Heat treatment

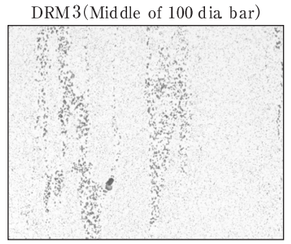
Re-forging Temperature	Heat treatment conditions (℃)			Hardness	
	Annealing	Quenching	Tempering	Annealed	Hardening / Tempering
Requested to inquire	800～880 Slow cooling	1100～1140 OQ , GC, Salt bath	550～620 AC, ≧twice	≦235HB	62～66HRC

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

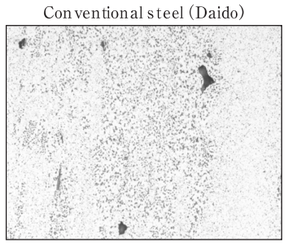
Microstructure (As annealed)

●Finely distributed coarse carbides

DRM3 (Middle of 100 dia. bar)



Conventional steel (Daido)

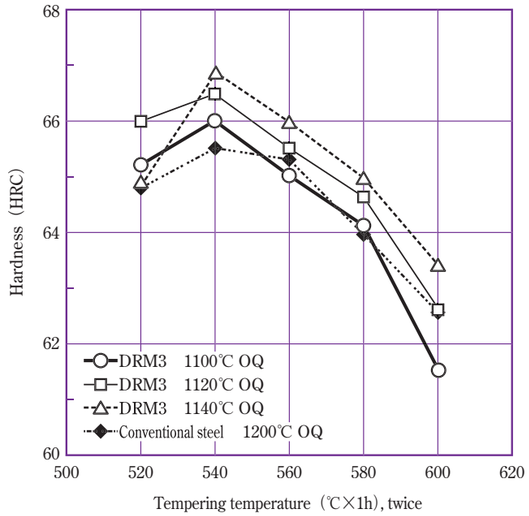


〈Cr_2O_3 Electrically etching〉

DAIDO STEEL

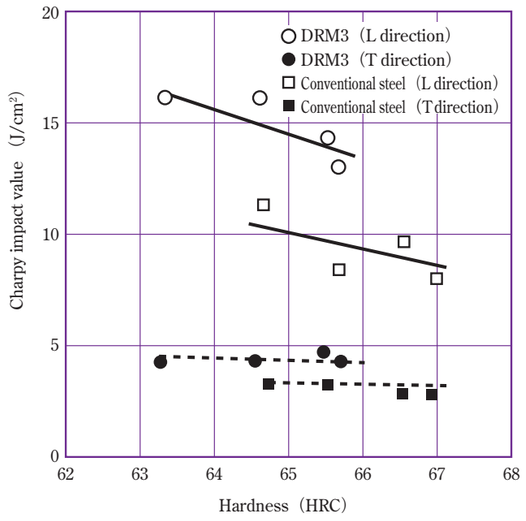
Characteristics

Tempering hardness



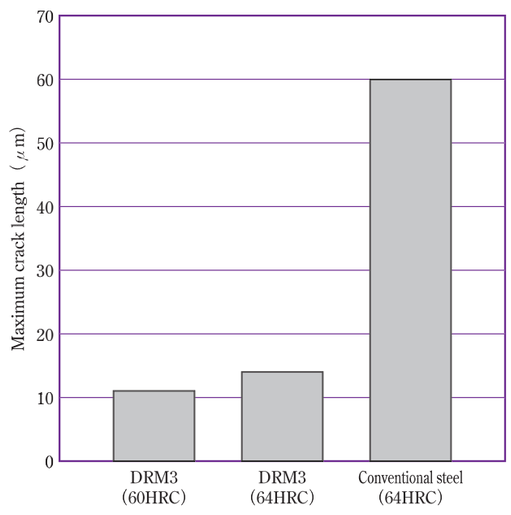
●Specimen ：15mm square
●Hardening ：Oil quenching
●Tempering ：Air cooling

Toughness : Charpy impact property



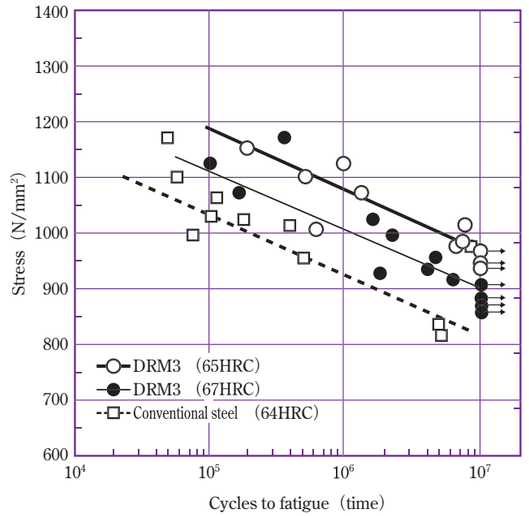
●Sampling ：100mm dia. Bar center
●Specimen ：10R notched
●Heat treatment ：DRM3……H：1140℃ OQ
T：540～600℃ AC, twice
Conventional Steel …H：1210℃ OQ
T：540～600℃ AC, twice

Heat checking resistance



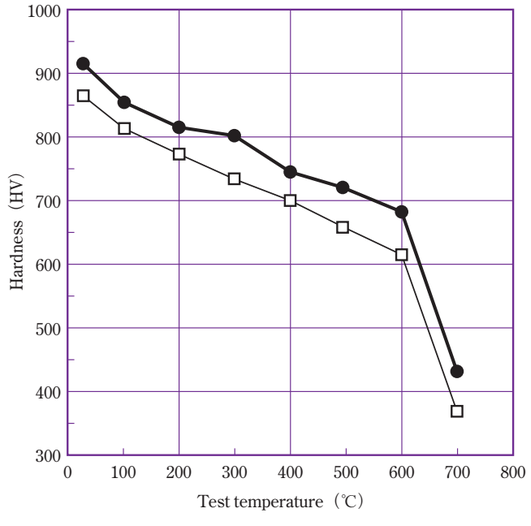
●Specimen ：15 mm dia. 10 mm thick
●Heat Treatment：DRM3…… H：1120℃ OQ
T：560～620℃ AC, twice
Conventional Steel …H：1200℃ OQ
T：560℃ AC, twice
●Test method ：Induction heating 20←→600℃ (1000 times)

Fatigue strength



●Heat Treatment：DRM3 (65HRC)… H：1100℃ OQ
T：560℃ AC, twice
DRM3 (67HRC)… H：1140℃ OQ
T：550℃ AC, twice
Conventional Steel … H：1200℃ OQ
T：560℃ AC, twice
●Test method ：Rotating bending fatigue test (20℃)

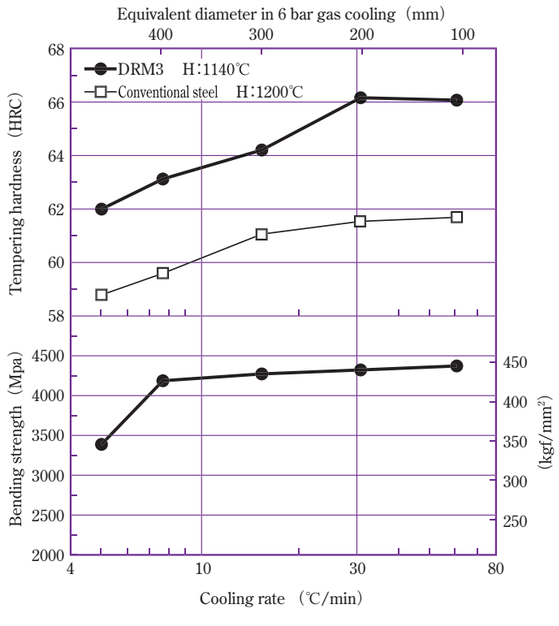
Hot hardness



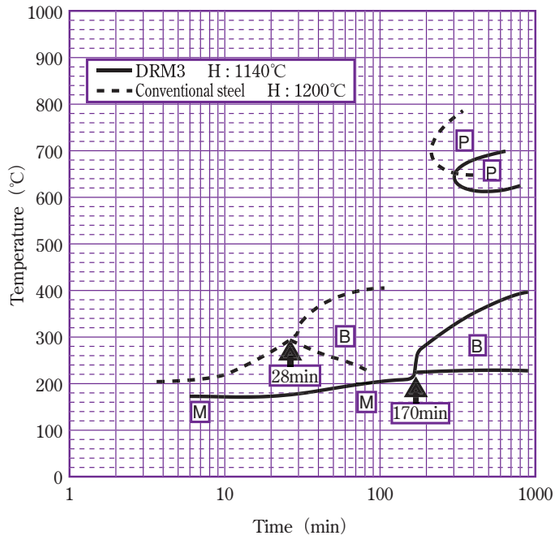
●Heat treatment：DRM3…… H：1140℃ OQ
T：560℃ AC, twice
Conventional Steel …H：1200℃ OQ
T：580℃ AC, twice

Hardenability

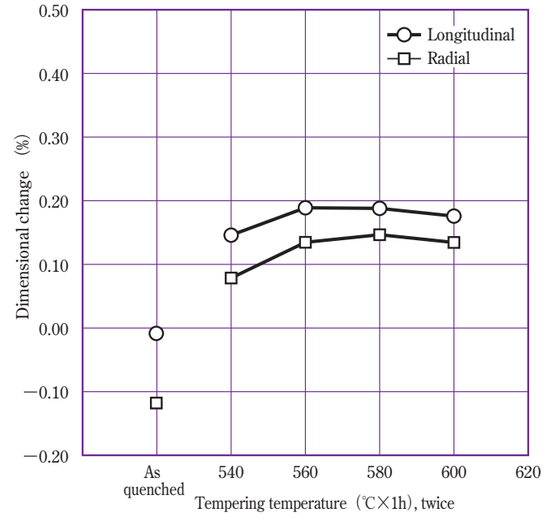
●Quenching cooling rate VS Bending strength Hardness



●Continuous cooling transformation curve



Dimensional changes in heat treatment



●Specimen ：100mm dia. × 60 mm
●Hardening：1140℃ salt bath quenching