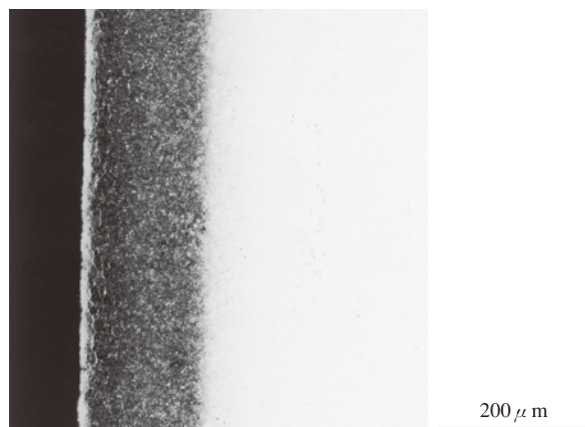


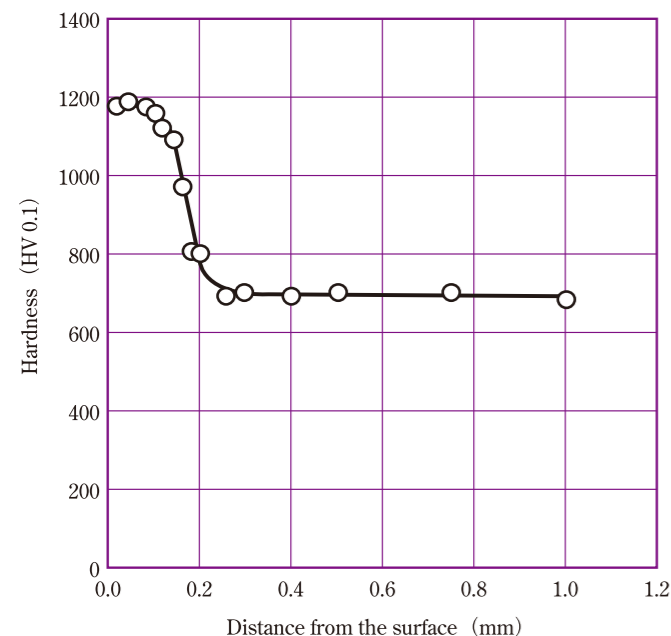
Nitriding characteristics

An example of micro structure nitrided by PS process

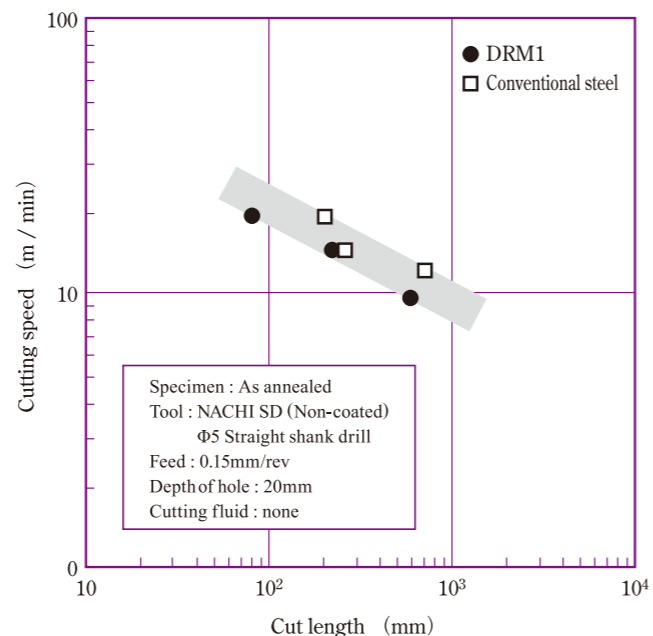
- PS process
- Daido Die & Mold Steel Solutions originally developed process featured by high scuffing and erosion resistance



● Hardness distribution



Drilling machinability



Physical properties

◆ Thermal expansion rate

| Temp. | 20~100°C | 20~200°C | 20~300°C | 20~400°C | 20~500°C | 20~600°C |
|----------------------|----------|----------|----------|----------|----------|----------|
| ×10 ⁻⁶ /K | 10.5 | 11.1 | 11.5 | 11.9 | 12.3 | 12.7 |

◆ Thermal conductivity

| Temp. | 25°C | 100°C | 200°C | 300°C | 400°C | 500°C | 600°C |
|-------|------|-------|-------|-------|-------|-------|-------|
| W/m·K | 25.3 | 26.8 | 27.7 | 29.0 | 28.9 | 28.3 | 28.9 |

*Accuracy of repeated measurements is about ±10%.

◆ Specific heat

| Temp. | 25°C | 100°C | 200°C | 300°C | 400°C | 500°C | 600°C |
|--------|------|-------|-------|-------|-------|-------|-------|
| J/kg·K | 466 | 491 | 513 | 557 | 591 | 631 | 724 |

◆ Young's modulus / Rigidity modulus / Poisson's ratio (25°C)

| Young's modulus | Rigidity modulus | Poisson's ratio |
|-----------------|------------------|-----------------|
| 212GPa | 81GPa | 0.31 |

Quenching: 1140°C×1h, Oil cooling
Tempering: 560°C×1h - Air cooling, Twice
Hardness: 58HRC

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.

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

Main applications

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

Heat treatment

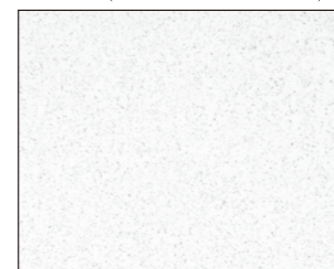
| Re-forging temperature | Heat treatment (°C) | | | Hardness | |
|------------------------|-------------------------|--------------------------------|------------------------|-----------|---------------------|
| | Annealing | Quenching | Tempering | Annealing | Quenched & Tempered |
| Requested to inquire | 800~880 Slow cooling | 1100~1140 OQ, GC, Salt bath | 550~620 AC, ≥ twice | ≤ 235HBW | 56~58HRC |

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

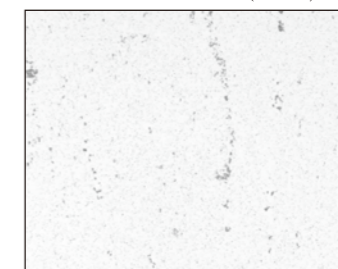
Microstructure (As annealed)

- Fine and uniform microstructure with less coarse carbides

DRM1 (Middle of 100 dia. bar)



Conventional steel (Daido)



25 μm
(Cr₂O₃ Electrically etching)



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DRM is a Registered trademark or Trademark of Daido Steel Co., Ltd.

■ Document Disclaimer

The product characteristics included in this brochure are the representative values based on the result of our measurements, and do not guarantee the performance in use of the products.

Please inquire the latest information to our department in charge as the information of this brochure is updated without previous notice as needed.

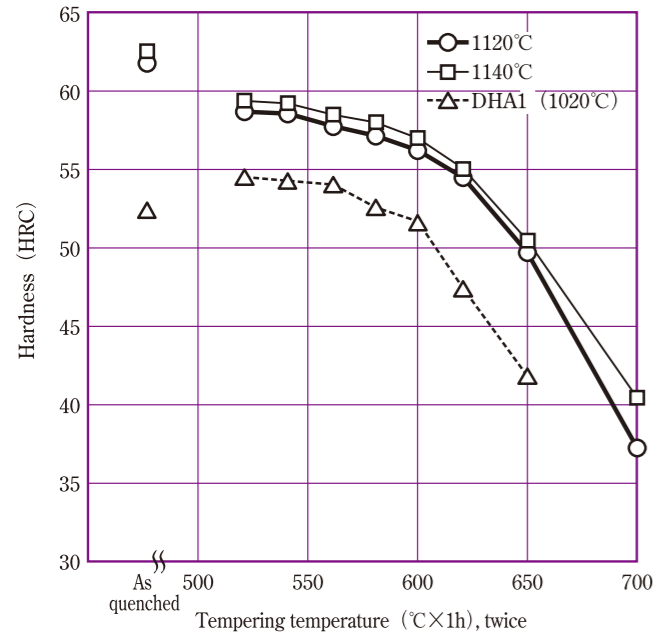
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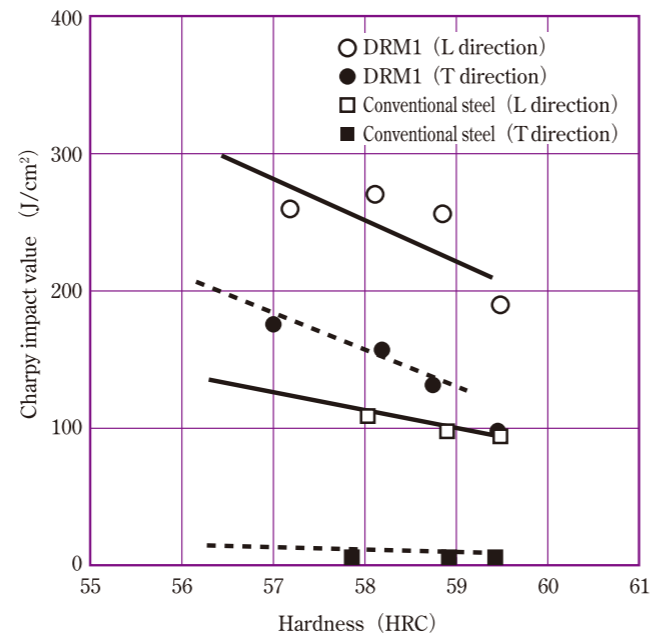
Properties

Tempered hardness



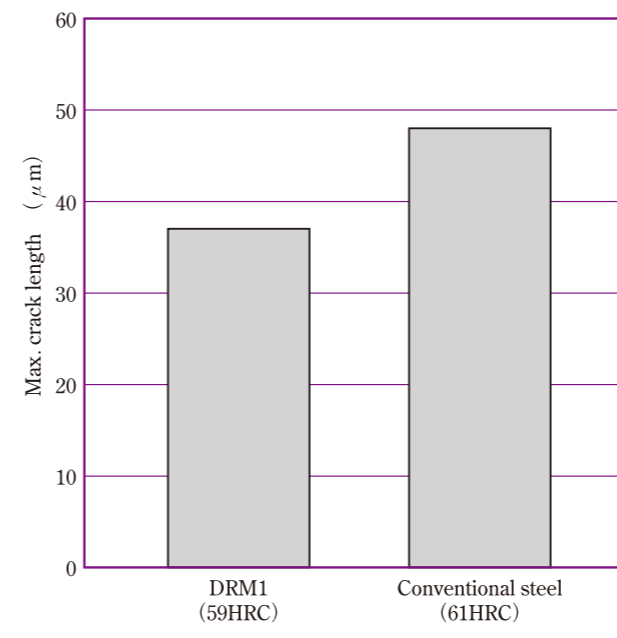
- Specimen : 15mm square
- Hardening : Oil quenching
- Tempering : Air cooling

Toughness



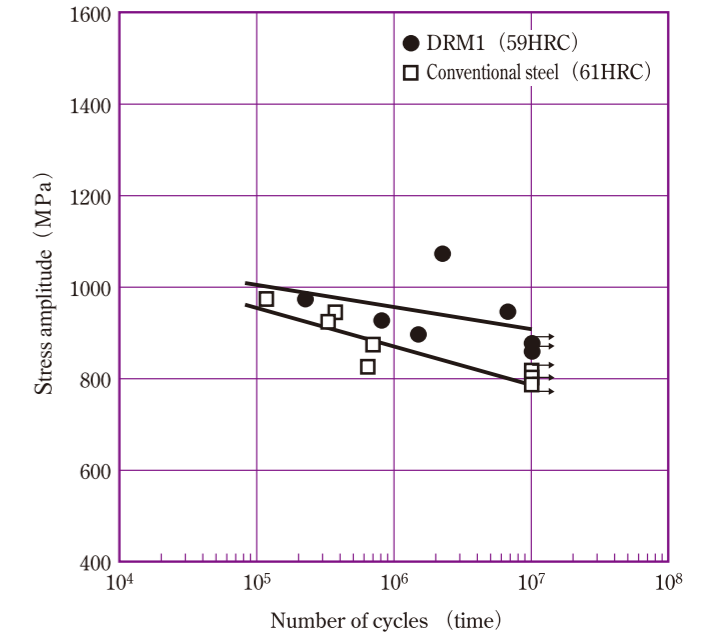
- Sampling : 100mm dia. Bar center
- Specimen : 10R notched
- Heat treatment : DRM1 H : 1140°C OQ
T : 540~600°C AC, twice
- Conventional Steel ... H : 1120°C OQ
T : 540~600°C AC, twice

Heat checking resistance



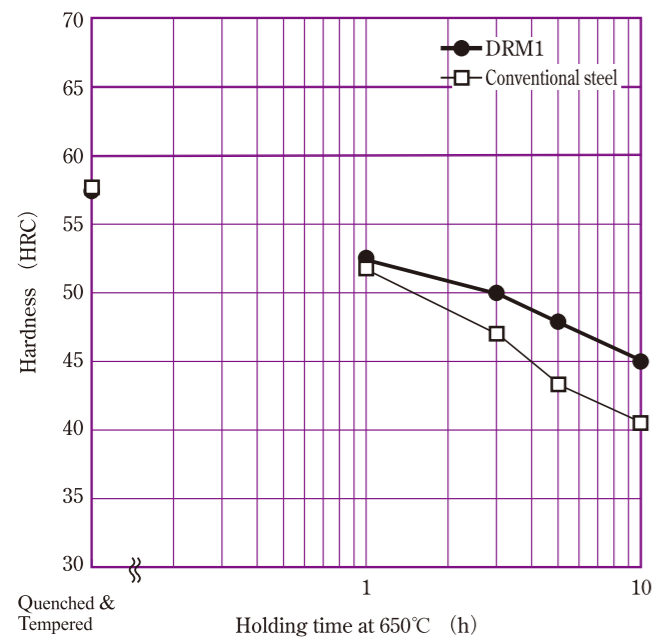
- Specimen : 15 mm dia. 10 mm thick
- Heat treatment : DRM1 H : 1140°C OQ
T : 560°C AC, twice
- Conventional Steel ... H : 1140°C OQ
T : 560°C AC, twice
- Test method : Induction heating 20 ← → 700°C (1000 times)

Fatigue strength



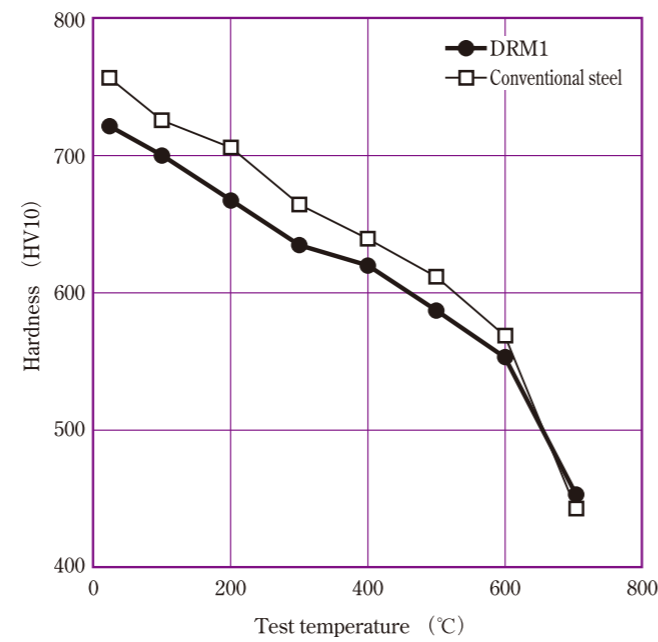
- Sampling : 100 mm dia. Bar center. L direction
- Heat treatment : DRM1 H : 1140°C OQ
T : 560°C AC, twice
- Conventional Steel ... H : 1140°C OQ
T : 560°C AC, twice
- Test method : Rotating bending fatigue test (20°C)

Softening resistance



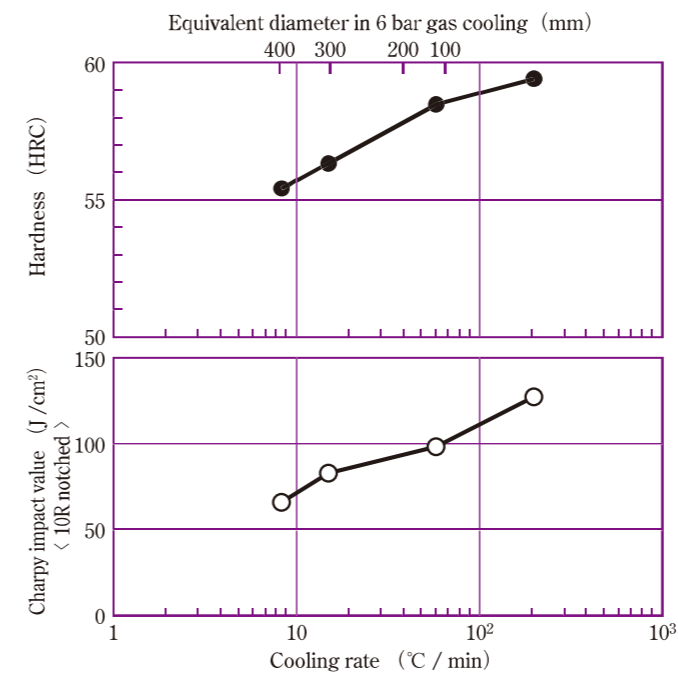
- Heat treatment : DRM1 H : 1140°C OQ
T : 600°C AC, twice
- Conventional Steel ... H : 1120°C OQ
T : 610°C AC, twice

Hot hardness



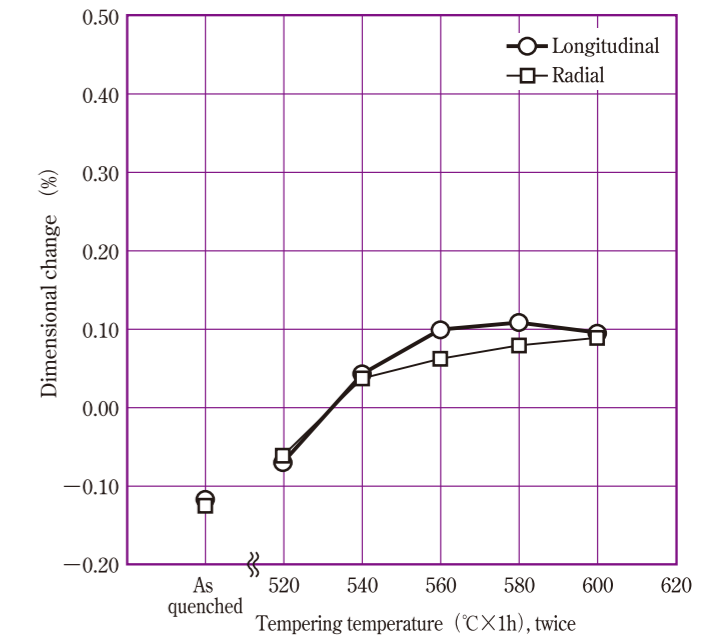
- Heat treatment : DRM1 H : 1140°C OQ
T : 560°C AC, twice
- Conventional Steel ... H : 1140°C OQ
T : 560°C AC, twice

Hardenability



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

Dimensional change



- Specimen : 100mm dia. × 60 mm
- Heat treatment H : 1140°C salt bath quenching