MOTION & CONTROL
NSK

Long-Life Bearings for Engine Accessories

New!

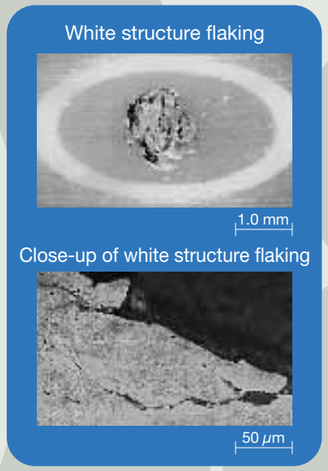
Patent approved

Our next-generation bearings for engine accessories—highly reliable and durable against premature white structure flaking.

How can we solve the problem with white structure flaking?

Engine accessories for automobiles need to be highly durable and reliable.

Bearings for engine accessories used under harsh conditions may generate white structure flaking.

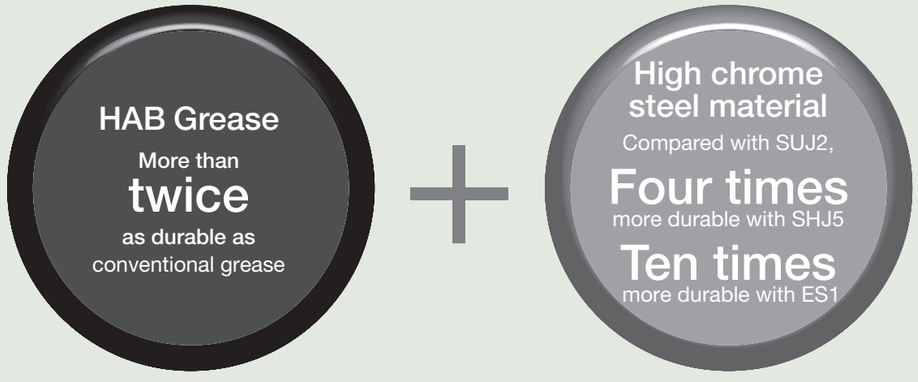


NSK bearings for engine accessories will solve the problem.

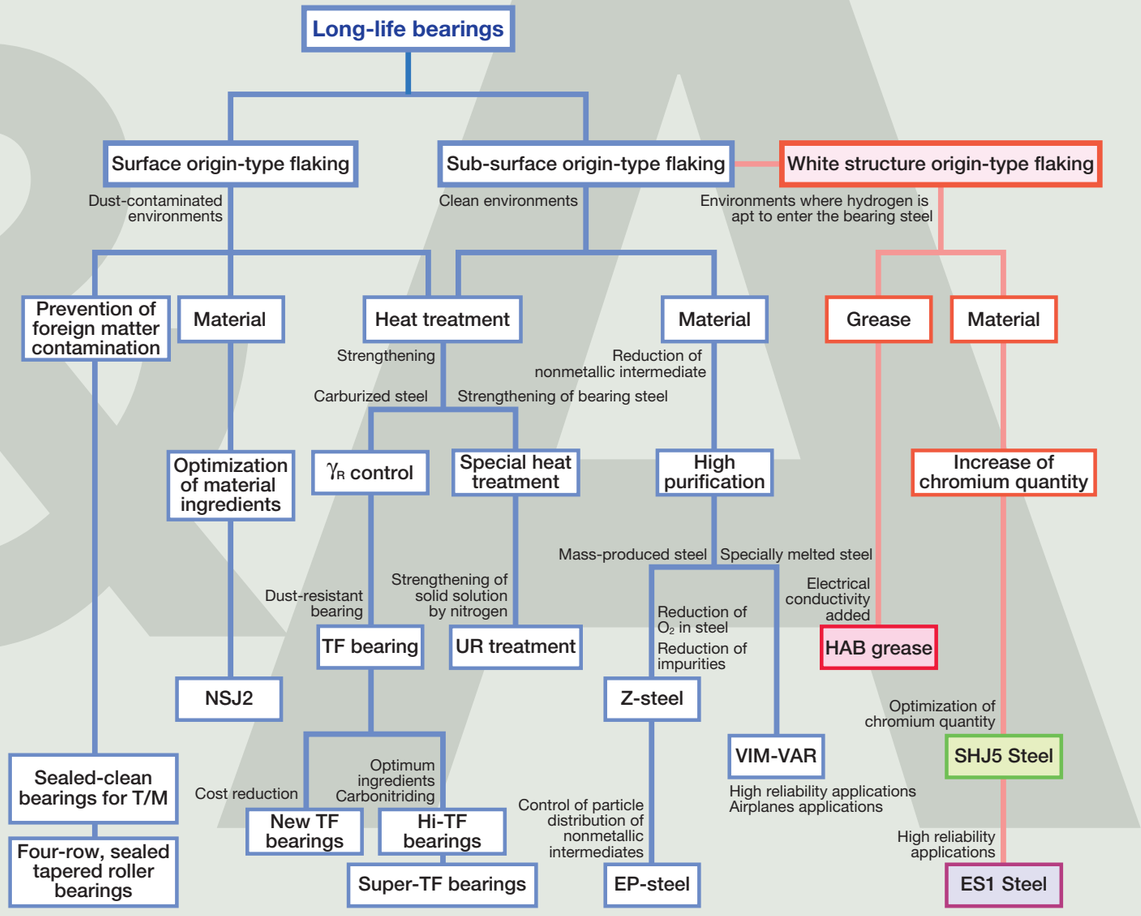
NSK has ascertained the cause of white structure flaking with our state-of-the-art technologies.

To solve the problem, we have developed new long-life bearings for engine accessories utilizing HAB grease and high chrome steel material. The new bearings are durable against white structure flaking, and offer excellent durability against seizure and rust, meeting vehicle needs well into the future.

<Durability against white structure flaking>



● Positioning and applications of high chrome steel material



Newly designed HAB grease and high chrome steel

Long-Life Bearings for Engine Accessories

Mechanism of white structure flaking and preventive measures to be taken

What are the causes of white structure flaking?

High surface pressure | Micro-slip | Water | Vibration

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Formation of a new surface at the area of rolling contact

<Catalyst of new surface formation>

Thickness of grease film

← Prevention of metallic contact by ensuring a solid grease film

↓

Generation of hydrogen ions caused by tribo-chemical reaction

← Electric conductivity effects of grease

↓

Static electricity generated between the pulley and belt discharges between the ball and ring, accelerating the generation of hydrogen, which is caused by the decomposition of grease.

← Inhibition of hydrogen intrusion/diffusion

↓

Intrusion and diffusion of hydrogen atoms into the steel

← Stable base structure for hydrogen

↓

Formation of white color structure

↓

Generation of white structure flaking

NSK eliminates the causes of white structure flaking.

Solutions

- Prevents metallic contact by ensuring a solid film of grease (oil film).
- Prevents static electricity from being generated between the pulley and belt by energizing the bearing at all times.

Solutions

- Inhibits intrusion and diffusion of hydrogen by reducing abrasion through fine dispersion of high-hardness chromium carbide.
- Prevents white etching constituents from forming by controlling diffusion (movement) of carbon atoms.

HAB grease

HAB grease combined with nanoscale carbon particles helps solve the problem.

High chrome steel material

High chrome steel, resistant to white structure flaking, also helps solve the problem.

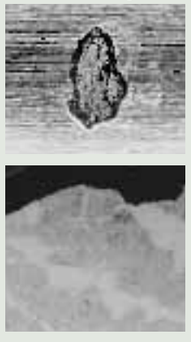
Newly designed HAB grease and high chrome steel

Long-Life Bearings for Engine Accessories

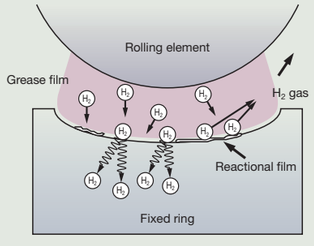
White structure flaking

Flaking patterns of bearings are largely classified into sub-surface origin-type flaking in clean environments and surface origin-type flaking in water- and dust-contaminated environments. White structure flaking is a sub-surface origin-type, not caused by a defect in inner materials such as nonmetallic intermediates, but by intrusion of hydrogen into the bearing steel generated by tribo-chemical reaction, which in turn forms a white etching constituent and generates flaking sooner than the end of the calculated operational life.

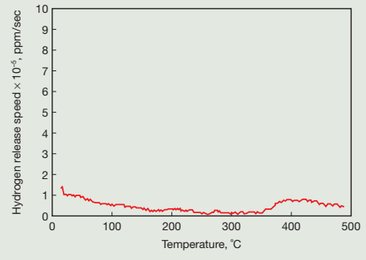
Close-up of white structure flaking seen in commercially available bearings



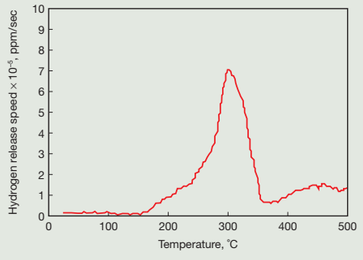
Conceptual diagram of hydrogen intrusion



Data set 1. Measured amount of hydrogen in bearings without flaking



Data set 2. Measured amount of hydrogen in bearings with flaking



Data sets 1 and 2 show the measured amount of hydrogen that intruded into the bearing after durability tests. Intrusion of hydrogen was seen in the bearing with flaking, with a peak at around 300℃. Intrusion of hydrogen was not found in the bearing without flaking, and no hydrogen peak was detected.

HAB grease and high chrome steel ensure long life and resistance to white structure flaking.

What are the performance characteristics of HAB grease and high chrome steel?

HAB Grease

An innovative grease, combined with nanoscale carbon particles, with electric conductivity.

HAB grease enables bearing use in environments up to **180˚C** by improving property stability at high temperatures. HAB grease contains no environmentally harmful substances. Furthermore, with electric conductivity, HAB grease is more than **twice** as durable against white structure flaking.

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High Chrome Steel

High chrome steel enhances the bearing's durability against white structure flaking.

The operational life of SHJ5 is **four times** longer than SUJ2, while ES1 lasts **ten times** longer than SUJ2. In addition, high chrome steel is excellent for dimensional stability and can be used in high-temperature environments.

Together they ensure unprecedented long life.

Four types of bearings for automobile engine accessories

Bearing specification	Bearing material	Grease
Current specification	SUJ2	Current grease
①Standard specification	SUJ2	HAB
②High-temperature specification	SHJ3	HAB
③Long-life specification	SHJ5	HAB
④Ultra long-life specification	ES1	—

① Standard specification

HAB grease-packed bearings enhance durability against white structure flaking. They are recommended as standard specification bearings for conventional uses of engine accessories.

② High-temperature specification

High heat-resistant bearings with SHJ3, which solve problems with SUJ2 in high-temperature environments, are recommended for engine accessories used at high temperatures, up to 180˚C.

<Characteristics of SHJ3>

1. Less softening during tempering due to dimensional stabilization treatment
2. Less softening in high-temperature environments
3. Excellent dimensional stability

③ Long-life specification

SHJ5 has longer operational life than SUJ2 and enables longer operational life than bearings with standard specifications.
This specification is recommended when downsizing of bearings is required.

④ Ultra long-life specification

ES1 provides maximum durability against white structure flaking.
This specification is optimal for bearings for engine accesories.

Long-Life HAB Grease

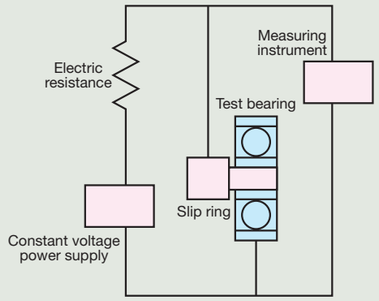
Prevention of metallic contact

- Nanocarbon forms a more solid grease film.
- The grease utilizes a thickener with stability (hardening/softening with time) at high temperatures.

Electric conductivity

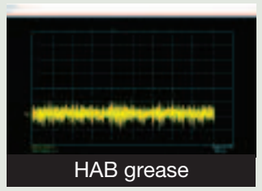
- Combined with electrically conductive substances, static electricity is prevented from charging between the pulley and the belt.

Results of HAB grease electric conductivity

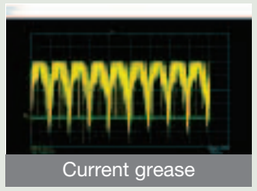


Test conditions
Bearing: 608 (ϕ 22 × ϕ × 8 × 7 mm)
500 min^{-1}, $F_r = F_a$ = 29.4N, 30°C

Electric conductivity: 93.2%



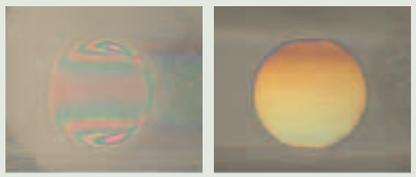
Electric conductivity: 12.1%



Measurement results for EHL oil film

Test conditions
Load: 176N
Speed: 0.5 m/s
Temperature: 20°C

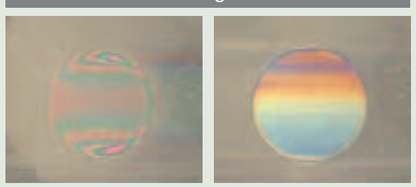
HAB



Grease supplied
(Minimum oil film thickness: 1.14 μm)

After one minute
(Minimum oil film thickness: 0.16 μm)

Current grease



Grease supplied
(Minimum oil film thickness: 1.14 μm)

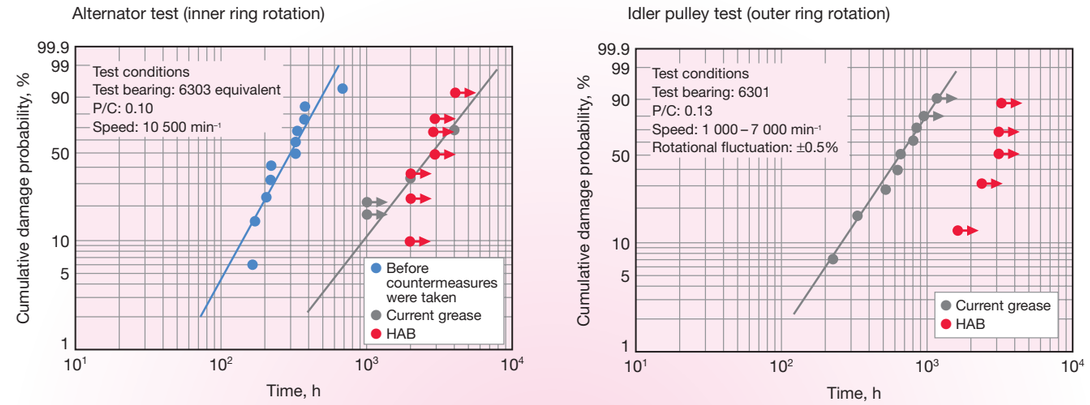
After one minute
(Minimum oil film thickness: 0.10 μm)

The oil film of HAB grease is more than 1.5 times thicker than that of conventional greases

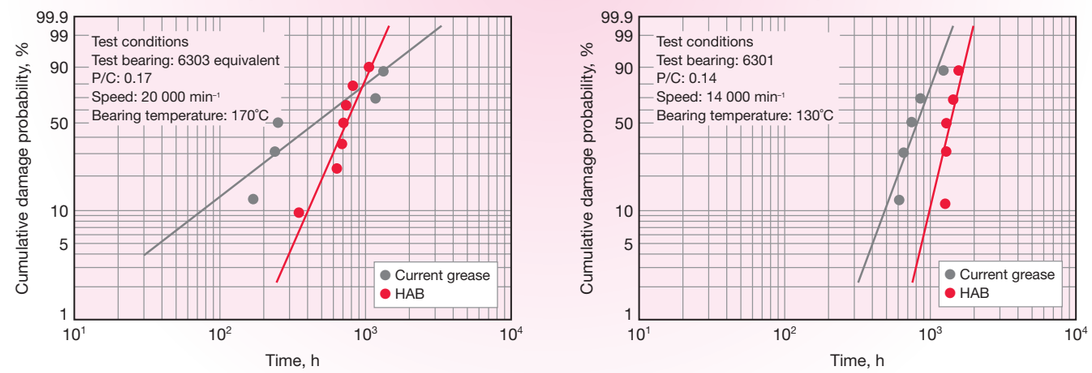
Representative properties of HAB grease

Item		HAB	Test method
Appearance		Black, buttery	
Thickener		Diurea	
Base oil		Ether oil	
Kinetic viscosity of base oil mm^2/sec	40°C	100	JIS K2283
	100°C	13	
Worked penetration 25°C, 60W		290	JIS K2220 (5.3)
Dropping point °C		260 or higher	JIS K2220 (5.4)
Copper corrosion 100°C, 24h		Passed	JIS K2220 (5.5B)
Evaporation %, 99°C, 22h		0.18	JIS K2220 (5.6B)
Oil separation %, 100°C, 24h		0.3	JIS K2220 (5.7)
Oxidation stability MPa, 99°C, 100h		0.02	JIS K2220 (5.8)
Worked stability 25°C, 10^{5}W		331	JIS K2220 (5.11)
Water washout resistance %, 79°C, 1h		1.0	JIS K2220 (5.12)
Low-temperature torque N · m	Activated	0.30	JIS K2220 (5.14)
	Rotations	0.10	
Rust test 0.1% NaCl 25°C, 48h, 100%RH		1, 1, 1	ASTM D1743

Measured durability data of HAB grease



Results of white structure flaking durability test (grease)



Results of seizure durability test (grease)

Blending nanoscale carbon particles into HAB grease creates electric conductivity, eliminating static electricity generated between the belt and the pulley. Since static electricity is not charged inside the bearing, discharge phenomena is reduced and decomposition of the grease is inhibited, which in turn prevents the generation of hydrogen. As a result, long-life HAB grease-packed bearings resist white structure flaking far better than conventional bearings and are also more resistant to seizing.

Long-Life High Chrome Steel

Improved wear resistance

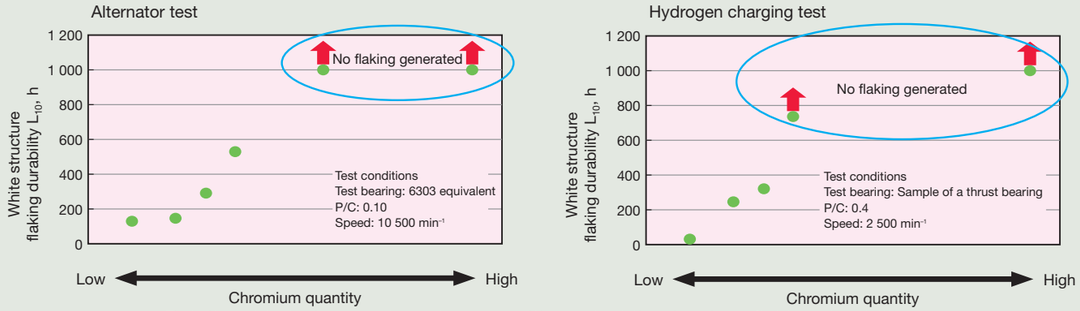
- Finely dispersing and precipitating, high-hardness chromium carbides inhibit abrasion, preventing new surface formation, and reduce tribo-chemical reactions (generation of hydrogen).

Inhibited hydrogen diffusion

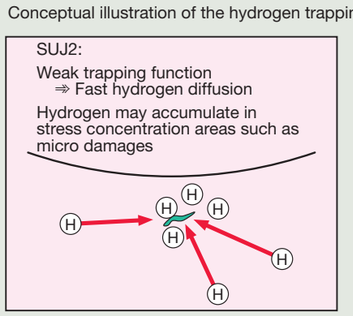
- High hydrogen trapping energy.

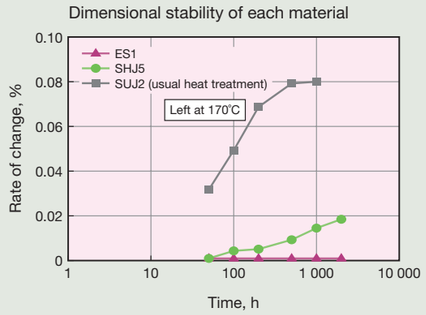
Stabilized carbide and base structures

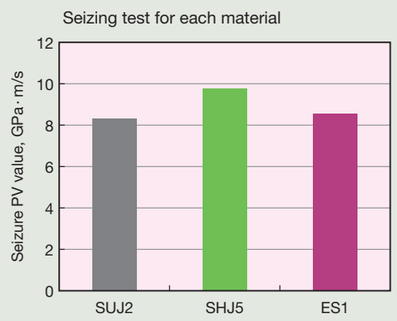
- Inhibits diffusion of carbon in steel, and controls formation of white etching areas.
- Compared with SUJ2, SHJ5 and ES1 have longer operational lives due to their abrasion resistance, hydrogen intrusion/diffusion inhibition, and stabilized carbide and base structures.

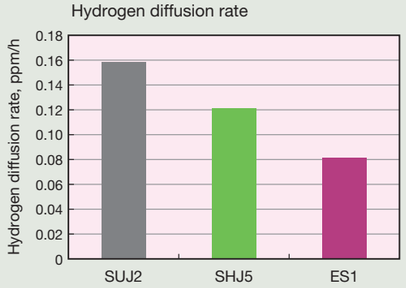


Relationship between chromium quantity and white structure flaking durability

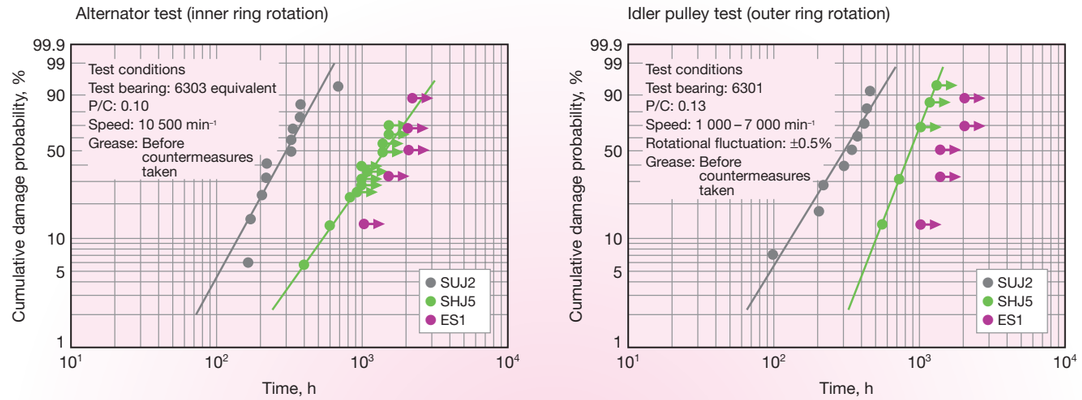




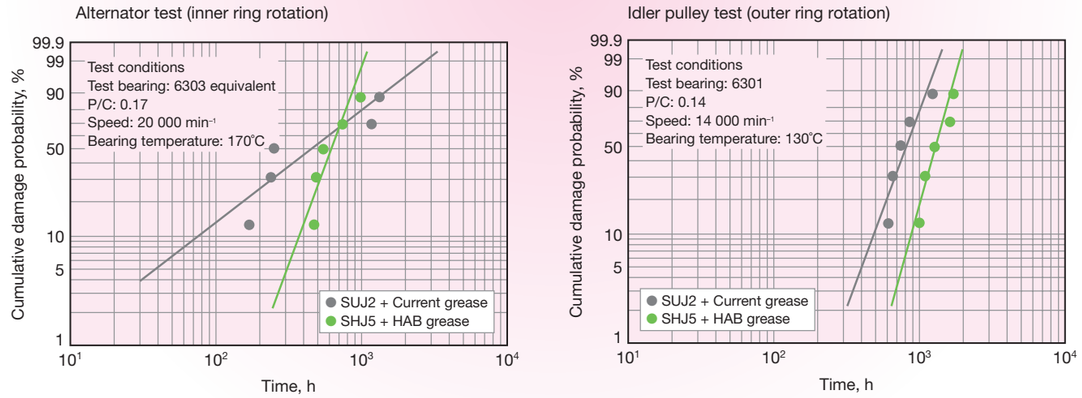




Measured durability data of SHJ5 and ES1

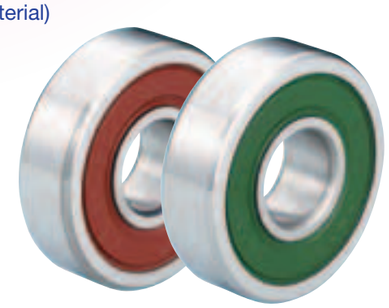


Results of white structure flaking durability test (material)



Results of seizure durability test (material)

By using high chrome steel as a bearing material to counter white structure flaking, wear resistance is improved, tribo-chemical reactions due to wear are reduced, intrusion/diffusion of hydrogen (hydrogen trapping effect) is inhibited, and carbides and base structure are stabilized (movement of carbon atoms is inhibited at the time of white etching area formation). SHJ5 and ES1 provide longer life against white structure flaking and exhibit higher durability against seizure than conventional materials.



Newly designed HAB Grease and High Chrome Steel

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