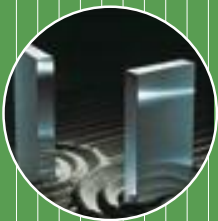


The BEST 10 New Products Nippon Brand Prize of The Nikkan sinbunn.

YSS COLD WORKING TOOL Steel **SLD MAGIC**



The arrival of a new die and mold material seeking longer mold lifespan and total cost reduction.

- Considerably prolongs lifespan of molds.
- Prevents scuffing of high-tensile steels during bending and drawing.
- Reduces reworking man-hours through minimal heat and surface treatment deformations.
- Shortens mold processing time via enhanced machinability.
- Lowers tool expenses by extending cutting tool lifespan.

Striving for the 21st century global standard.

Concept

SLD-MAGIC (S-MAGIC) is the revolutionary next-generation die steel attaining both extended mold lifespan and outstandingly easy mold fabrication.

S-MAGIC Features

Wear resistance

High hardness of 62HRC improves wear resistance by approximately 35%*.

Surface treatment

Adherence between the coating layer and steel after surface treatment (CVD and other methods) is improved by approximately 30%*.

Heat treatment

Minimal deformation during heat treatment for a reduction of approximately 40%* in dimensional changes.

Machinability

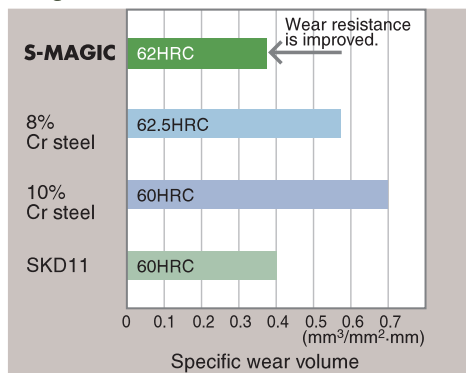
Machinability improved by approximately 35%*

*Hitachi Metals comparison: Comparison against 8%Cr steel (Hitachi Metals product name:SLD8), a modified steel of SKD11.

Wear resistance

S-MAGIC increases wear resistance by approx. 35% compared with 8% Cr steel due to the control of carbide morphology.

Ohgoshi-method wear test

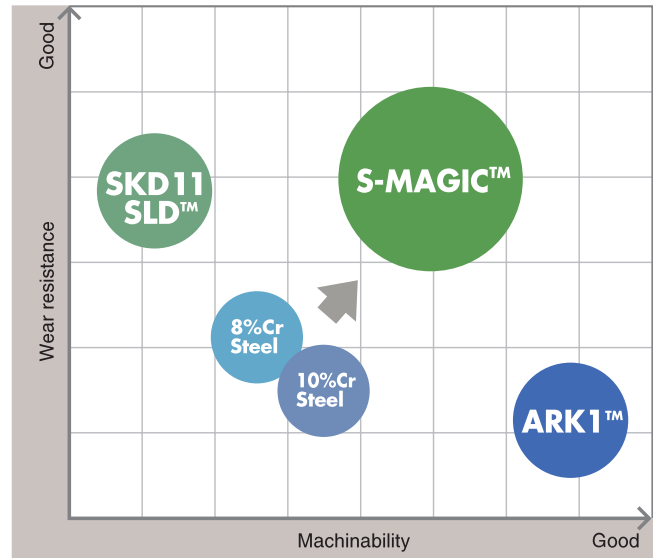


Work material: SCM415
Friction distance: 400m
Friction speed: 0.76m/s
Load: 67N

SLD-MAGIC

M: Materials Magic
A: Advanced
G: Gratifying
I: Innovative
C: Cold work die steel

Relationship



Comparison of Properties

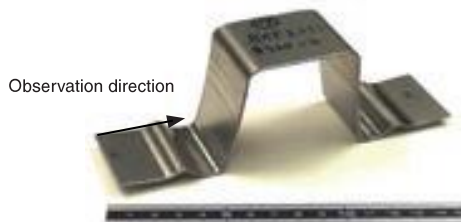
Grade	S-MAGIC	8% Cr Steel	10% Cr Steel	SKD11
Hardness (HRC)	60-62	61-63	59-61	58-60
Wear resistance	◎	○	○	◎
Surface treatment*	◎	△	△	○
Toughness	○	○	△	△
Machinability	○ ⁺	△	○	×
Dimensional change by heat treatment	◎	△	△	○
Weldability	○	○	△	△

◎ ○⁺ ○ △ ×
← Excellent Poor →

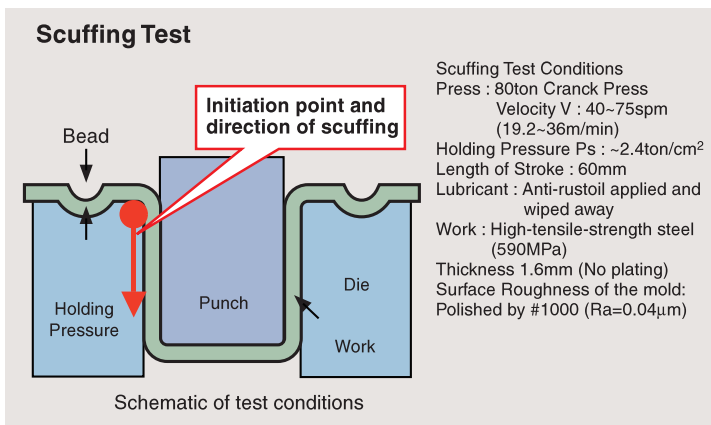
*Surface treatment properties are based on adherence between the coating layer and steel after surface treatment.
8%Cr steel and 10%Cr steel offer improved machinability for better processing that reduces the volume of hard carbides within steel, but are inferior to SKD11 in terms of wear resistance and galling.

Scuffing resistance

S-MAGIC shows no scuffing on Hat Testing simulating practical mold wear phenomena.



Appearance of work Sample



Surface treatment

S-MAGIC can be treated with hard coating (CVD, TD treatment etc.) under the same conditions as SKD11. S-MAGIC improves adherence between the coating

layer and steel after 3-time surface treatment by approx. 30% when compared with 8%Cr steel, due to optimum alloy design.



Weldability

S-MAGIC shows lower susceptibility of cracking by welding compared with SKD11 and others.

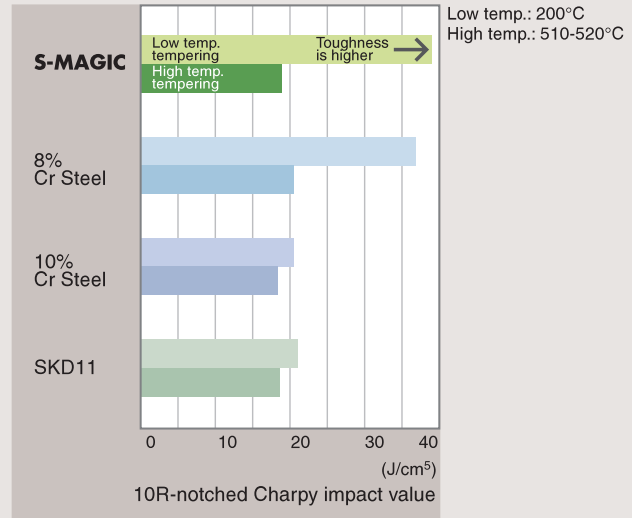
Pre-heating temperature	S-MAGIC	SKD11	8%Cr Steel	10Cr Steel
Under 100°C	××	××	××	××
100~200°C	○	××	××	××
200~300°C	○	××	○	××
Over 300°C	-	○	○	○
ranking of anti-cracking	1	3	2	3

Welding rod: SKD61 grade φ4.0mm
 Welding current: 130A (AC)
 ××: Cracking occurred at 3rd layer
 ○ : No cracking at 3rd layer

Toughness

S-MAGIC is superior to SKD11 in toughness. It can be used as a countermeasure to chipping and cracking with low temp. tempering.

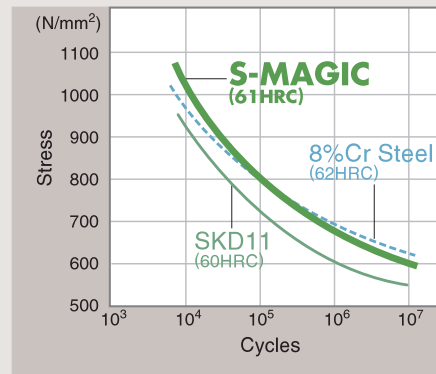
10R-notched Charpy impact value



Fatigue strength

S-MAGIC shows improved fatigue strength in comparison to SKD11 due to the control of carbide morphologies.

Rotating bending fatigue test



Physical Properties

Thermal expansion coefficient X10 ⁻⁶ /°C	20~100°C	20~200°C
	11.7	12.3

Thermal conductivity W/m·K	Room temperature
	28.9

Specific gravity	Annealed	Quenched and tempered
	7.77	7.76

Young's modulus GPa	209
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Transformation temperature	Ac1	Ms temperature
	850°C	166°C

Heat Treatment

It is possible to heat treat S-MAGIC under the same conditions as SKD11.

It is possible to obtain maximum hardness (60~62HRC) with tempering at around 500°C where dimensional change is near to zero, achieving both high hardness and less dimensional change.

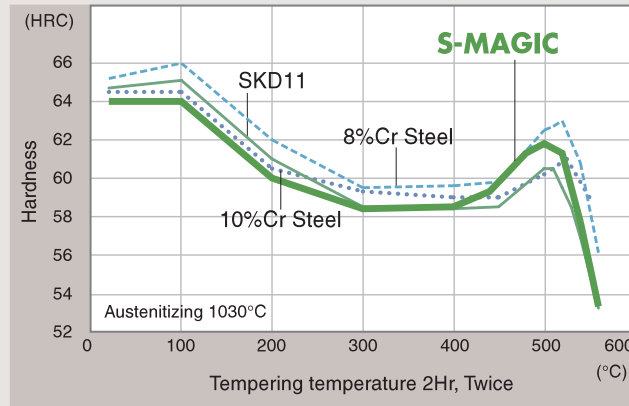
Secular change of S-MAGIC after high temp. tempering is almost equivalent to that of SKD11, and smaller than 8% Cr steel. It is possible to reduce secular change via low temp. tempering, sub-zero treatment or stabilizing.

Size of test pieces: 45T X 90W X 200L
 Austenitizing: 1030°C
 Low temp. tempering: 180°C X 2times
 High temp. tempering: 520°C X 2times
 Measure: 200mm direction
 Dimensional change after 6 months posterior heat treatment

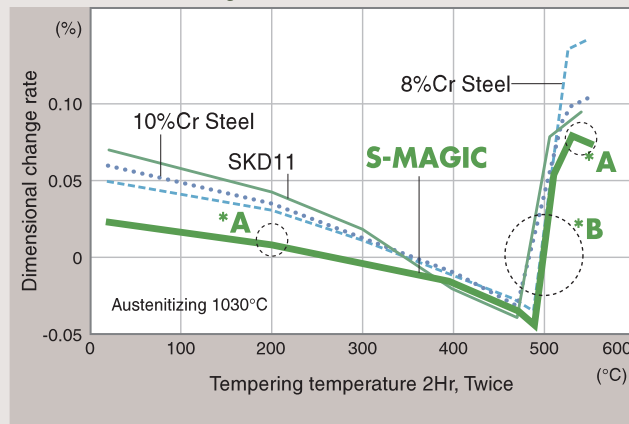
Standard Heat Treatment Conditions

Annealed Hardness	Austenitizing	Tempering	Hardness (HRC)
≤ 255HBW	1010~1040°C Air quenching	480~530°C Air cooling or 150~250°C Air cooling	≥ 60

Quenched and tempered hardness

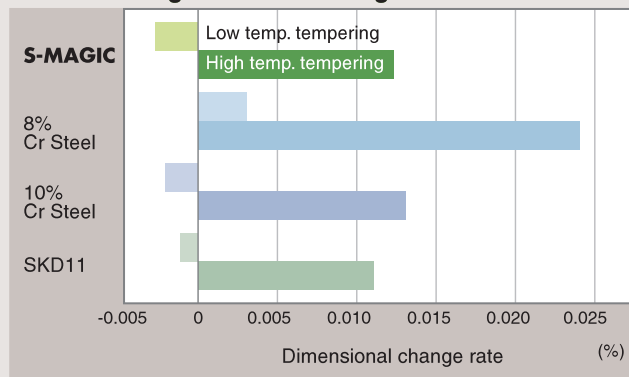


Dimensional change after heat treatment



*A: Minor dimensional change
 *B: Minor dimensional change with maximum hardness

Secular change / Dimensional growth



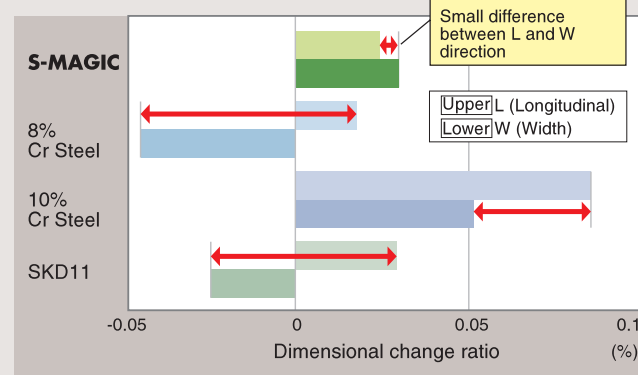
Heat Treatment

S-MAGIC shows smaller in dimensional change difference in the longitudinal, width and thickness directions, compared to SKD11 or 8% Cr steels.

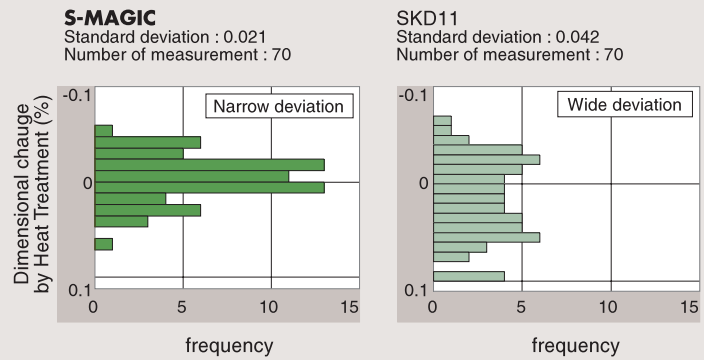
S-MAGIC shows narrow deviation of dimensional changes by heat treatment, as a result, the better dimensional tolerance can be attained.

For example, in case of separation type molds, mold set up time was largely decreased because of narrow dimensional deviation.

Secular change/Dimensional change



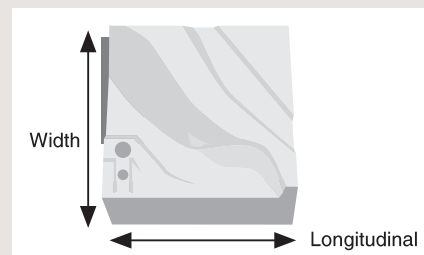
Deviation comparison of dimensional changes of actual mold after heat treatment.



Grade	Direction	(mm) Original Dimension	(mm) dimensional Change	(%) dimensional Change ratio	Mold set up time
S-MAGIC	W	295	-0.030	-0.010	46 ←
	L	250	+0.010	+0.004	
SKD11	W	295	-0.090	-0.031	100(Index)
	L	250	+0.130	+0.052	

54% reduction of mold adjusting time after heat treatment

Example of dimensional change for insert type mold.



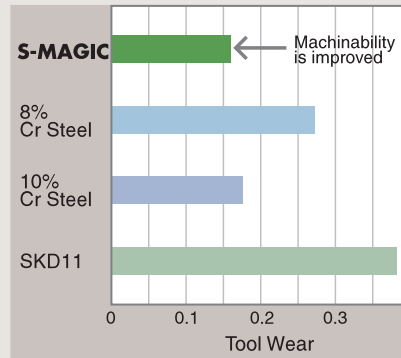
Machinability

S-MAGIC improves machinability on face mill by over twice that of SKD11 and by approx. 35% compared to 8% Cr steel. It also demonstrates superior machinability using other tools.

Mold processing time is shortened due to enhanced machinability.

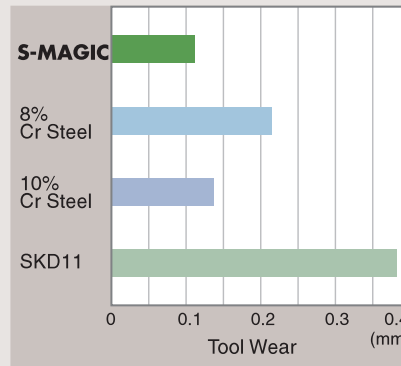
The lifespan of cutting tools is increased, thus reducing direct purchasing costs of tools.

ø125 Face Mill



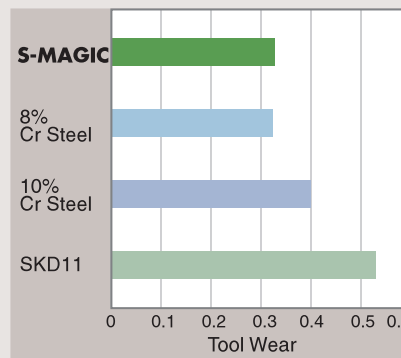
Work: Annealed condition
 Tool: Coated carbide chip, 1 chip only
 Cutting speed: 120m/min, Dry
 Feed: 0.13mm/blade
 Depth of cut: 2° X 90°mm,
 Cutting distance: 4m

End Mill



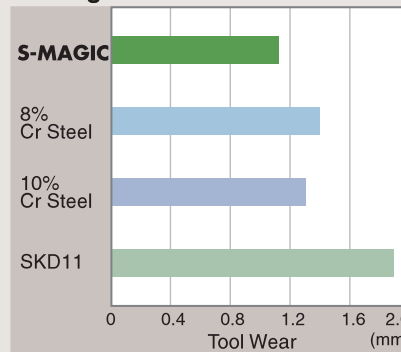
Work: Annealed condition
 Tool: End mill ø8 (Co-HSS)
 Cutting speed: 30m/min, Down-cut, Wet
 Feed: 0.05mm/tooth
 Depth of cut: 15° X 0.5°mm,
 Cutting distance: 5m

Drill



Work: Annealed condition
 Tool: Drill ø5 (Co-HSS)
 Cutting speed: 20m/min, Wet
 Feed: 0.05mm/ev
 Depth of hole: 25mm, 200Holes

ø63 High feed cutter



Work: Annealed condition
 Tool: Coated carbide chip
 Cutting speed: 150m/min, Dry
 Feed: 1.3mm/tooth
 Depth of cut: 1mm,
 Cutting distance: 60m

Machinability

S-MAGIC can enhance tool lives because of lower cutting tool temperatures.



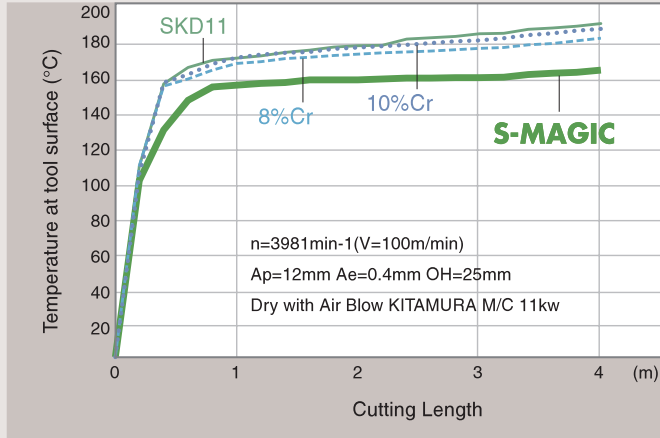
S-MAGIC



SKD11
(Tempered color)

Cutting tool temperature comparison

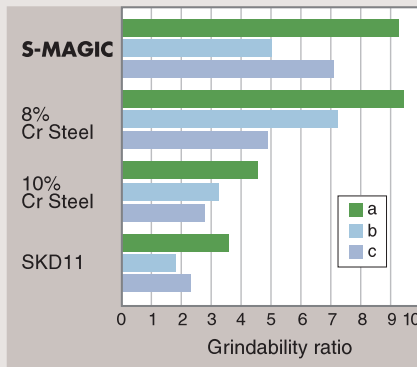
CEPR6080 (ultrafine particle WC) (ø8 X 6NT TiAlN)



Grindability

Grindability of S-MAGIC is better than those of SKD11 and 10% Cr steel, and almost equivalent to 8% Cr steel.

Grindability comparison as a function of different grinding wheels



Grinding test conditions

- Work 50 X 90 X 200L (Heat treated condition)
- Machine: Reciprocal Type
- Grinding Wheel
 - a: Alumina Single Crystal
 - b: Alumina
 - c: Alumina + Other ceramics

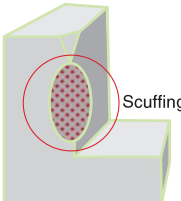
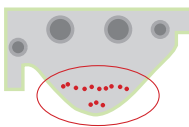
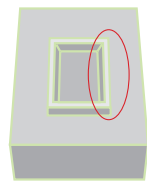
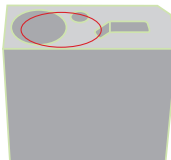
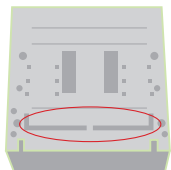
Grinding Conditions

- Wet Traverse Grinding
- Velocity of Wheel 33m/sec
- Table velocity 0.33m/sec
- Undercut 5µm/pass
- Cross Field 5mm/lap
- Spark out 1lap
- Total undercut 0.1mm

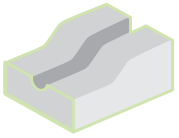
- Grinding ratio Ground off amount/wear of wheel
- Grinding ratio is higher the better

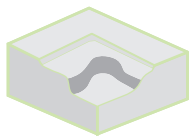
Application Examples

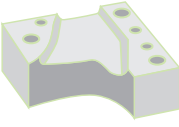
In addition to prolonging the lifespan of molds, S-MAGIC also enables remarkably easy mold fabrication, thereby contributing to total cost reduction and shorter processing times in the automobile and mold industries.


01 Bending die for automotive parts Inner parts Work 440MPa (t3.2)		Present condition	Evaluation	 <p>Scuffing</p> <p>Mold lifespan significantly improved</p>
	Grade	SKD11	S-MAGIC	
	Hardness	59-61HRC	60-62HRC	
	Heat treatment	High temp. Tempering	High temp. Tempering	
	Surface treatment	CVD (TiC)	CVD (TiC)	
	Lifespan	1,300 pcs	156,000 pcs	
	Cause	Severe galling	Less galling	
02 Blanking die for automotive parts Function parts Work 590MPa (t7.0)		Present condition	Evaluation	 <p>Chipping</p> <p>Mold lifespan more than doubles</p>
	Grade	SKD11	S~MAGIC	
	Hardness	58-60HRC	58-60HRC	
	Heat treatment	170°C Tempering	170°C Tempering	
	Machinability	Bad	Good	
	Lifespan	15,000 pcs Max.	40,000 pcs carrying on	
	Cause	Severe chipping	Less chipping	
03 Blanking die for electrical appliances Electrical appliances Work Film		Present condition	Evaluation	 <p>Mold lifespan 50% up</p>
	Grade	SKD11	S-MAGIC	
	Hardness	58-60 HRC	58-60 HRC	
	Heat treatment	530°C Tempering	530°C Tempering	
	Machinability	Bad	Good	
	Lifespan	650,000 pcs	1,020,000 pcs	
	Cause	Early wear out	Less wear	
04 Blanking die for electrical appliances Optical parts Work SPCC (t0.8)		Present condition	Evaluation	 <p>Mold lifespan doubles</p>
	Grade	SKD11	S-MAGIC	
	Hardness	60-62HRC	60-62HRC	
	Heat treatment	200°C Tempering	480°C Tempering	
	Machinability	Bad	Good	
	Lifespan	100,000 pcs	100,000 pcs carrying on	
	Cause	Burr (Wear out)	Reduce wear by half	
05 Blanking die for electrical appliances Liquid crystal panel parts Work SUS304 (t0.3)		Present condition	Evaluation	 <p>Mold lifespan 30% up</p>
	Grade	8%Cr Steel	S-MAGIC	
	Hardness	60-62HRC	60-62HRC	
	Heat treatment	505°C Tempering	480°C Tempering	
	Dimensional change	0.05%	-0.01-0.02%	
	Lifespan	30,000 pcs	40,000 pcs carrying on	
	Cause	Burr (Wear out)	Less wear	

! Note: The above-listed data is for application examples only and this data does not assure performance. It is not suited for molds with EDM finished surface that require a high degree of mirror finish such as plastic molds.

06 Die for hydroforming Exhaust pipe Work Steel tube		Present condition	Evaluation	 Mold adjusting time is reduced because of small dimension change of upper and lower die blocks by heat treatment
	Grade	SKD11	S-MAGIC	
	Hardness	56HRC	58HRC	
	Heat treatment	High temp. Tempering	High temp. Tempering	
	Distortion by heat treatment	Very hard to adjusting the upper and lower die blocks due to large dimensional changes	Reduction of adjusting time of the upper and the lower die blocks	
	Machinability	Bad	Improved. Adjusting is finished only by one chip used.	

07 Die for cold press Automobile parts Work High-tensile -strength steel		Present condition	Evaluation	 Small dimension deviation
	Grade	SKD11	S-MAGIC	
	Hardness	58-60HRC	60-62HRC	
	Heat treatment	High temp. Tempering Large dimensional change	High temp. Tempering Deviation is reduced to 1/2. Adjusting time is reduced	
	Cause	Ball End Miuing Exchanging chips quite often	The number of exchanged chips is reduced to 1/5-1/10 compared to SKD11. Feed rate is increased to 1.7 times.	

08 Die for cold press Inner parts Work 440MPa (t2.3)		Present condition	Evaluation	 Mold lifespan is improved by almost 3 times.
	Grade	SKD11	S-MAGIC	
	Hardness	58-60HRC	60-62HRC	
	Heat treatment	High temp. Tempering	High temp. Tempering	
	Surface treatment	TD	Dimensional Changes by TD is within 5/100	
	Problem	Scuffing	Continuing beyond 15,000	

09 Die for cold press Inner parts Work 780MPa (t2.3)		Present condition	Evaluation	 Small dimension changes after TD treatment
	Grade	SKD11	S-MAGIC	
	Hardness	59-61HRC	60-62HRC	
	Heat treatment	High temp. Tempering	High temp. Tempering	
	Surface treatment	TD	Dimensional Changes by TD is small	
	Problem	Machinability and dimension change	The life of chips used is 10 times longer than SKD11 cases.	

! Note: The above-listed data is for application examples only and this data does not assure performance. It is not suited for molds with EDM finished surface that require a high degree of mirror finish such as plastic molds.