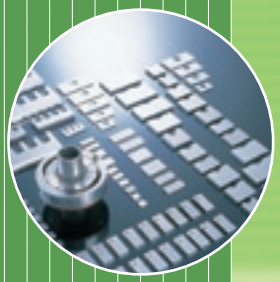
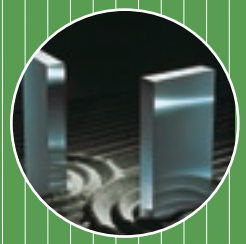
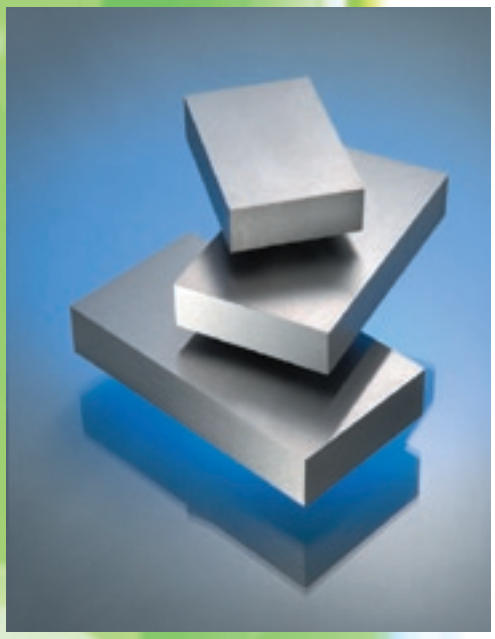
The BEST 10 New Prodacts Nippon Brand Prize of The Nikkan sinbunn.

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 bendingand drawing.
- Reduces reworking man-hours through minimal heatand surface treatment deformations.
- Shortens mold processing time via enhancedmachinability.
- 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.

SLD-MAGIC

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

S-MAGIC Features

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

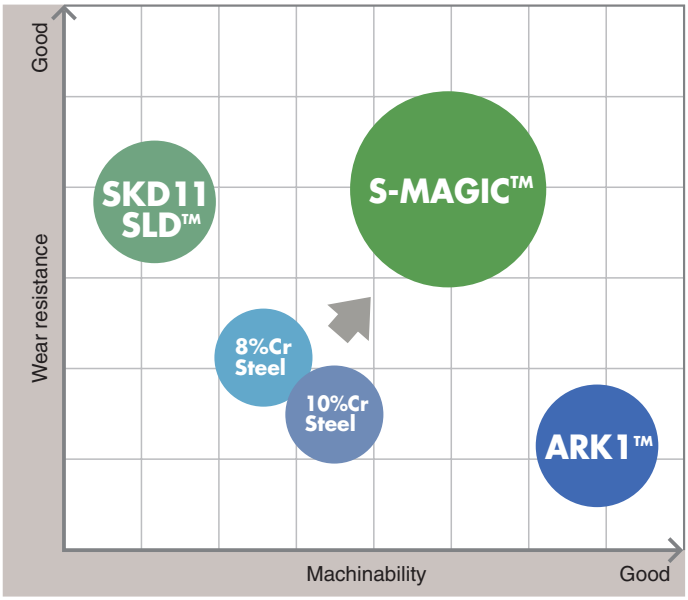
Surface treatment
Adherence between the coating layer and steel after surface treatment (CVD and other methods) is improved by approximately 30%*.

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.

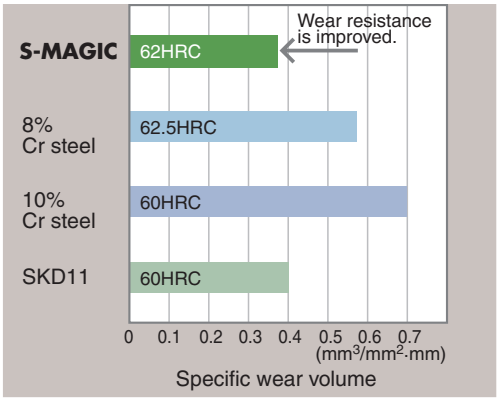
Relationship



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

Comparison of Properties

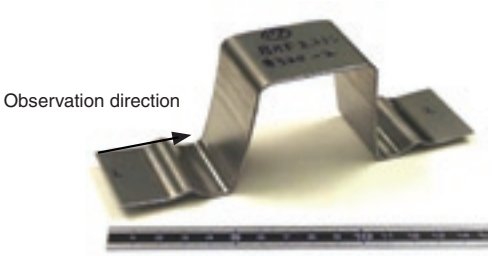
Grade	S-MAGIC	8% Cr Steel	10% Cr Steel	SKD11
Hardness (HRC)	60-62	61-63	59-61	58-60
Wear resistance	◎	○	○	◎
Surface treatment*	◎	△	△	○
Toughness	○	○	△	△
Machinability	○+	△	○	×
Dimensional change by heat treatment	◎	△	△	○
Weldability	○	○	△	△

◎ ○+ ○ △ ×
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.

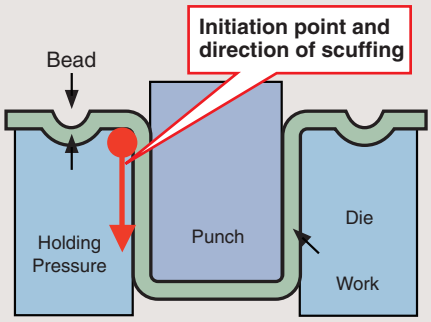
Scuffing resistance

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



Appearance of work Sample

Scuffing Test



Schematic of test conditions

Scuffing Test Conditions
Press : 80ton Cranck Press
Velocity V : 40~75spm (19.2~36m/min)
Holding Pressure Ps : ~2.4ton/cm²
Length of Stroke : 60mm
Lubricant : Anti-rustoil applied and wiped away
Work : High-tensile-strength steel (590MPa)
Thickness 1.6mm (No plating)
Surface Roughness of the mold: Polished by #1000 (Ra=0.04μm)

Scuffing Observation

S-MAGIC

Mold surface

No scuffing

Work Surface

SKD11

Mold surface

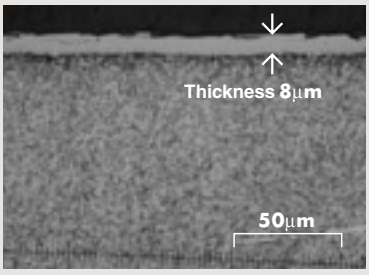
Scuffing

Work Surface

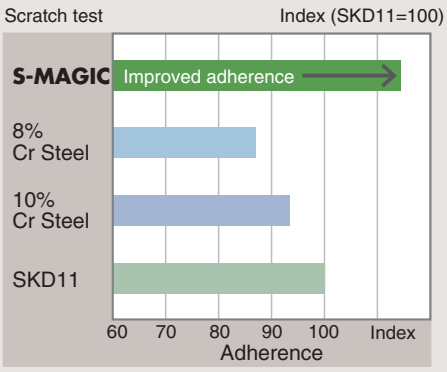
Surface treatment

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.

Coating Layer by CVD method



Adherence between the coating layer and steel after 3-time CVD treatment.



Weldability

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

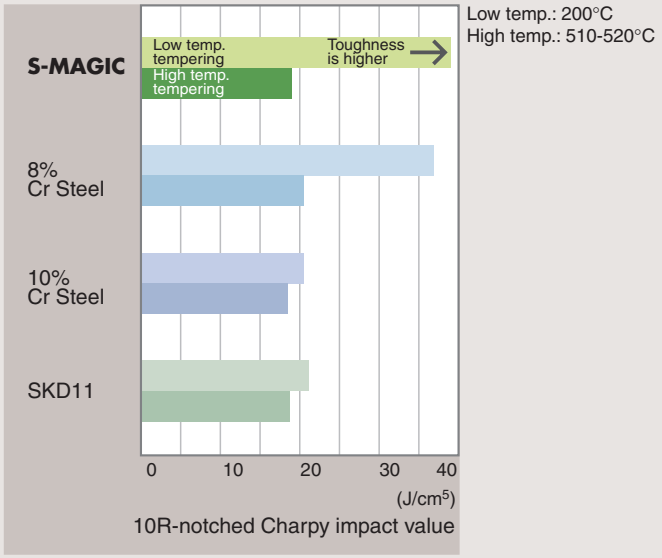
Pre-heating temperture	S-MAGIC	SKD11	8%Cr Steel	10Cr Steel
Under 100°C	××	××	××	××
100~200°C	○	××	××	××
200~300°C	○	××	○	××
Over 300°C	-	○	○	○
ranking of anti-cracking	1	3	2	3

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

Toughness

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

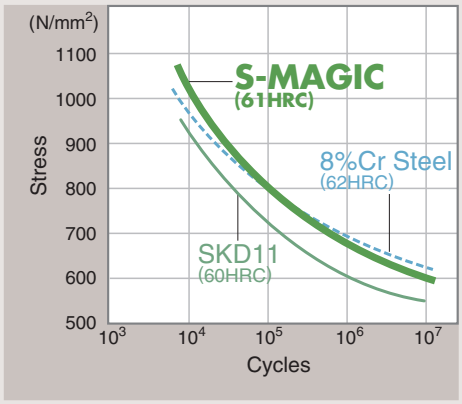
10R-notched Charpy impact value



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

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.

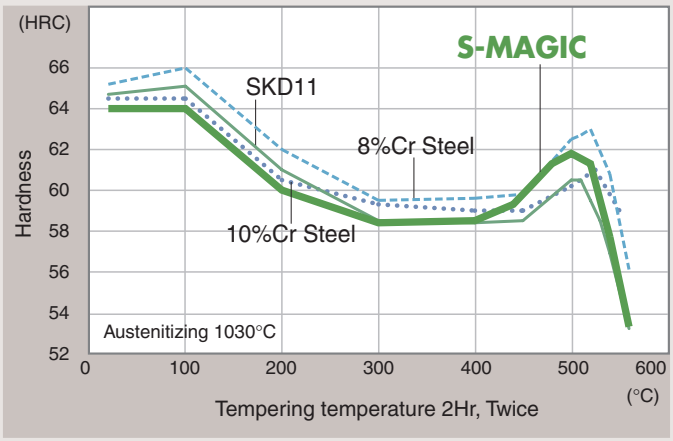
It is possible to obtain maximum hardness (60~62HRC) with tempering at around 500°C where dimensional change is near to zero, achieving both high hardness and less dimensional change.

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.

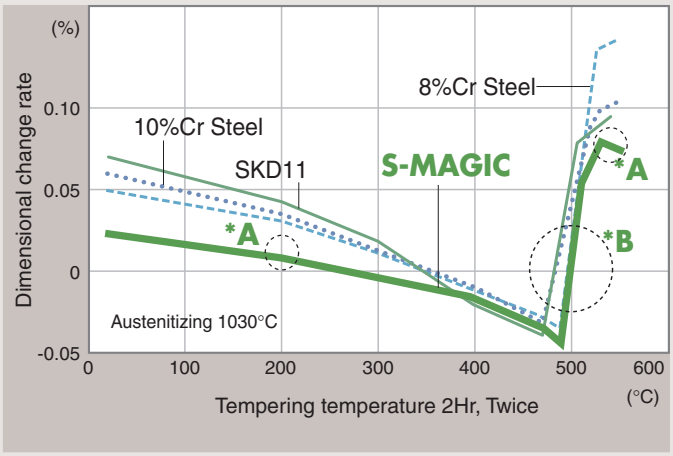
Standard Heat Treatment Conditions

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

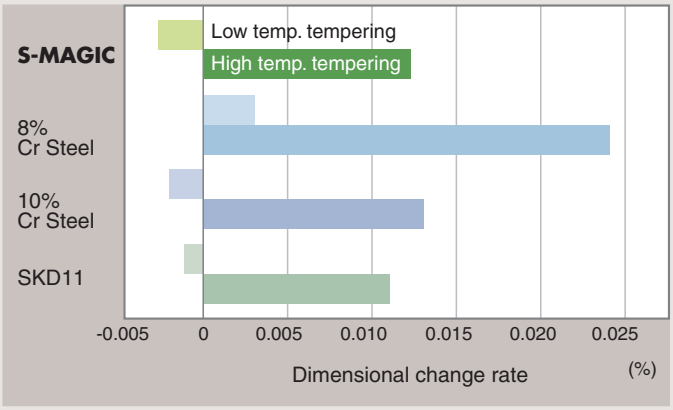


Dimensional change after heat treatment



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

Secular change / Dimensional growth

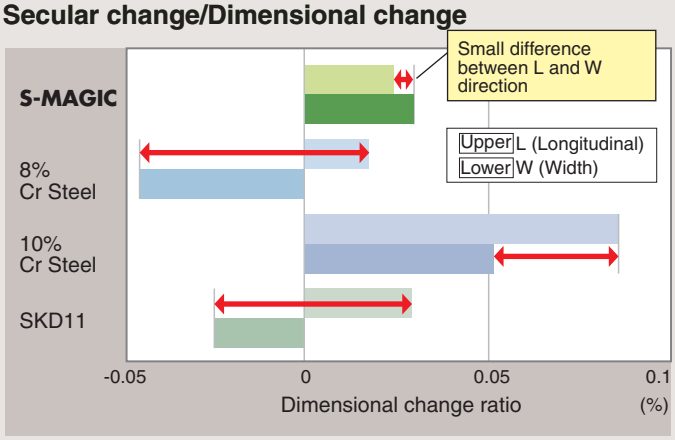


Size of test pieces: 45T X 90W X 200L
Austenitizing: 1030°C
Low temp. tempering: 180°C X 2times
High temp. tempering: 520°C X 2times
Measure: 200mm direction
Dimensional change after 6 months posterior heat treatment

Heat Treatment

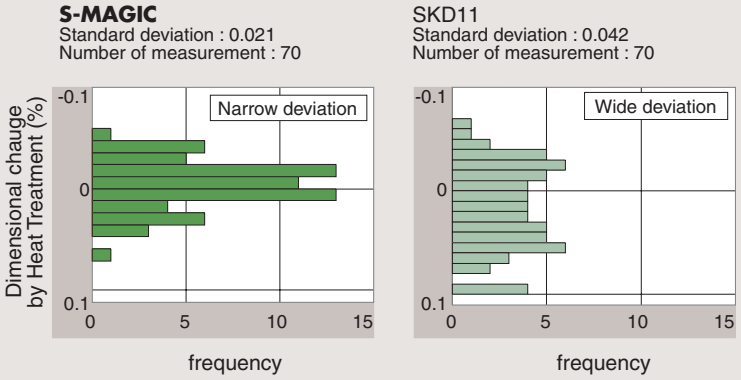
S-MAGIC shows smaller in dimentional change difference in the longitudinal, width and thickness directions, compared to SKD11 or 8% Cr steels.

Secular change/Dimensional change



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

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

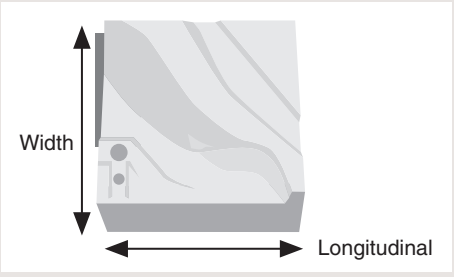


For example, in case of separation type molds, mold set up time was largely decreased because of narrow dimensional deviation.

Grade	Direction	(mm) Original Dimension	(mm) demensional Change	(%) demensional 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 ajusting time after heat treatment

Example of dimensional change for insert type mold.



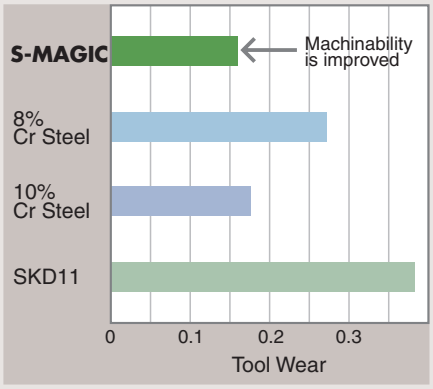
Machinability

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.

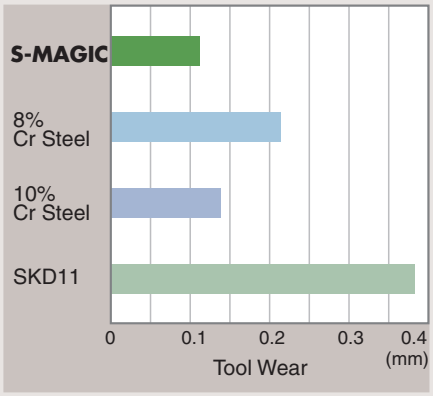
The lifespan of cutting tools is increased, thus reducing direct purchasing costs of tools.

ø125 Face Mill



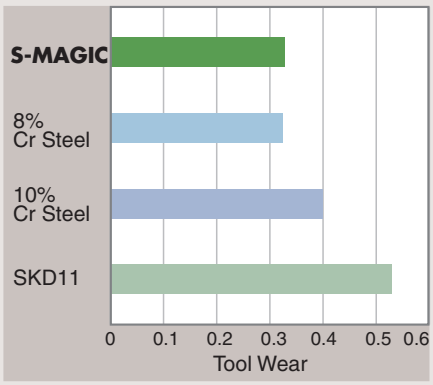
Work: Annealed condition
Tool: Coated carbide chip, 1chip only
Cutting speed: 120m/min, Dry
Feed: 0.13mm/blade
Depth of cut: 2^{Z} X 90^{W}mm,
Cutting distance: 4m

End Mill



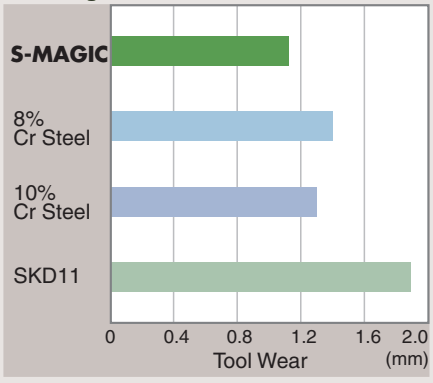
Work: Annealed condition
Tool: End mill ø8 (Co-HSS)
Cutting speed: 30m/min,Down-cut,Wet
Feed: 0.05mm/tooth
Depth of cut: 15^{Z} X 0.5^{W}mm,
Cutting distance: 5m

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

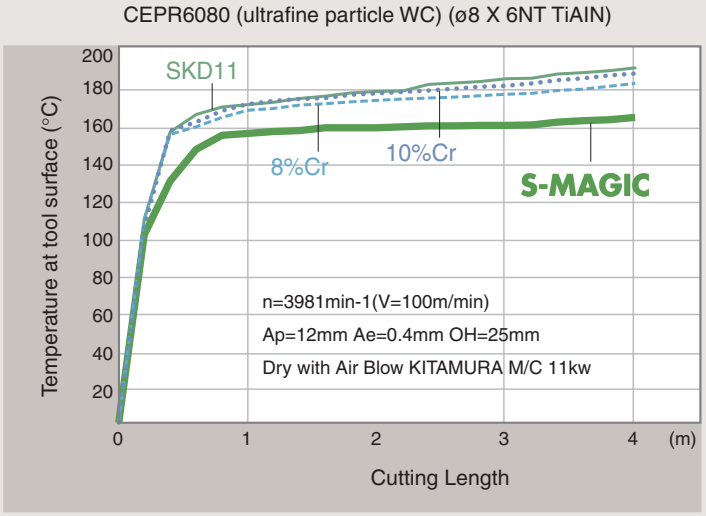
Machinability

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

S-MAGIC

SKD11
(Tempered color)

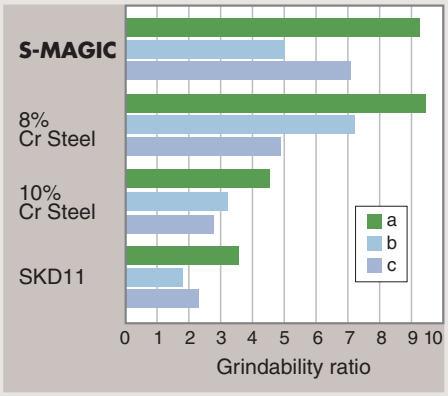
Cutting tool temperature comparison



Grindability

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

Grindability comparison as a function of diffenent 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

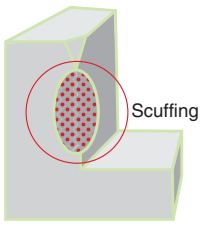
Application Examples

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
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

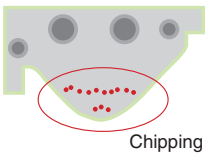


Mold lifespan significantly improved

02 Blanking die for automotive parts

Function parts
Work 590MPa (t7.0)

	Present condition	Evaluation
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

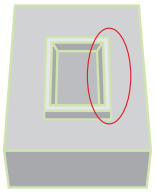


Mold lifespan more than doubles

03 Blanking die for electrical appliances

Electrical appliances
Work Film

	Present condition	Evaluation
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

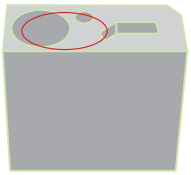


Mold lifespan 50% up

04 Blanking die for electrical appliances

Optical parts
Work SPCC (t0.8)

	Present condition	Evaluation
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

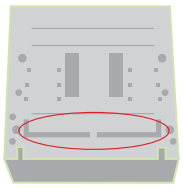


Mold lifespan doubles

05 Blanking die for electrical appliances

Liquid crystal panel parts
Work SUS304 (t0.3)

	Present condition	Evaluation
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



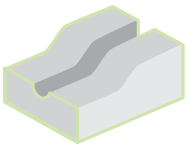
Mold lifespan 30% up

⚠ 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

Exhawst pipe
Work Steel tube

	Present condition	Evaluation
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 clue 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.

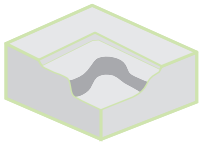


Mold adjusting time is reduced because of small dimension change of upper and lower die blocks by heat treatment

07 Die for cold press

Automobile parts
Work Hight-tensile
-strength steel

	Present condition	Evaluation
Grade	SKD11	**S-MAGIC**
Hardness	58~60HRC	60~62HRC
Heat treatment	High temp. Tempering Large dimensional ohange	High temp. Tempering Deviation is reduced to 1/2. Ajusting time is reduced
Surface treatment	TD	TD
Cause	Ball End Miuing Exchanging chips quite offen	The number of exchanged chips is reducedto 1/5~1/10 compared to SKD11. Feed rate is increased to 1.7 times.

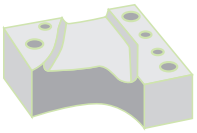


Small dimension deviation

08 Die for cold press

Inner parts
Work 440MPa (t2.3)

	Present condition	Evaluation
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
Lifespan	5500 pcs	Continuing beyond 15,000
Problem	Scuffing	



Mold lifespan is improved by almost 3 times.

09 Die for cold press

Inner parts
Work 780MPa (t2.3)

	Present condition	Evaluation
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
Machinability	Bad	The life of chips used is 10 times longer than SKD11 cases.
Problem	Mochinabiliry and dimension change	

Small dimension changes after TD treatment

⚠ 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.

Hitachi Metals, Ltd. http://www.hitachi-metals.co.jp/

Head Office	SEAVANS North Building, 1-2-1, Shibaura, Minato-ku, Tokyo 105-8614, Japan Specialty Steel Company	Tel. +81-3-5765-4410 Fax. +81-3-5765-8317

Hitachi Metals America, Ltd.

Head Office	2 Manhattanville Road, Suite 301, Purchase, NY 10577, U.S.A.	Tel. +1-914-694-9200 Fax. +1-914-694-9279
Other Office	Chicago, Detroit, Charlotte, San Jose	

Hitachi Metals Europe GmbH

Head Office	Immermannstrasse 14-16,40210 Duesseldorf, Germany	Tel. +49-211-16009-0 Fax. +49-211-16009-29

Hitachi Metals Singapore Pte. Ltd.

	12 Gul Avenue, Singapore 629656	Tel. +65-6861-7711 Fax. +65-6861-1519

Hitachi Metals (Shanghai) Ltd.

	11F, Tian An Center, No.338 NanJing Road (West), Shanghai, 200003, China	Tel. +86-21-6358-6368 Fax. +86-21-6358-6327

Hitachi Metals(Dong Guan)Specialty Steel Co.,Ltd.

Guangzhou Liaison Office	Cha Shan Town, Dong Guan City, 522380 China	Tel. +86-769-640-6726 Fax. +86-769-640-6716
Dalian Branch	3-2, Koushin Mould Industrial Park Ⅲ B-1-1-1F. T. Z. Dalian, China	Tel. +86-411-8718-1011/1022 Fax. +86-411-8718-1033
Tianjin Branch	No.13 Workshop, Wenxin Industrial Park, Jingxiang Road, Xiaodian Town, Beichen Economic Development Zone, Tianjin, China	Tel. +86-22-8699-3101/3102 Fax. +86-22-8699-3103

Hitachi Metals, Ltd.

Beijing Liaison Office	Room No.1418, Beijing Fortune Building,5 Dong San Huan Bei-Lu, Chaoyang District, Beijing, 100004 China	Tel. +86-10-6590-8775 Fax. +86-10-6590-8776
Guangzhou Liaison Office	R3303, Metro plaza,183 Tianhebei Road Tianhe District, Guangzhou city, Guangdong, 510075 China	Tel. +86-20-8755-3649 Fax. +81-20-8755-3650

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Our address and contact indicated in this catalog are those as of November 2007.
If you cannot put a call through, please contact our Corporate Communication Group. in Tokyo below.
Tel:+81-3-5765-4076
Fax:+81-3-5765-8312
E-mail : hmcc@hitachi-metals.co.jp

January 2008 (PDF)