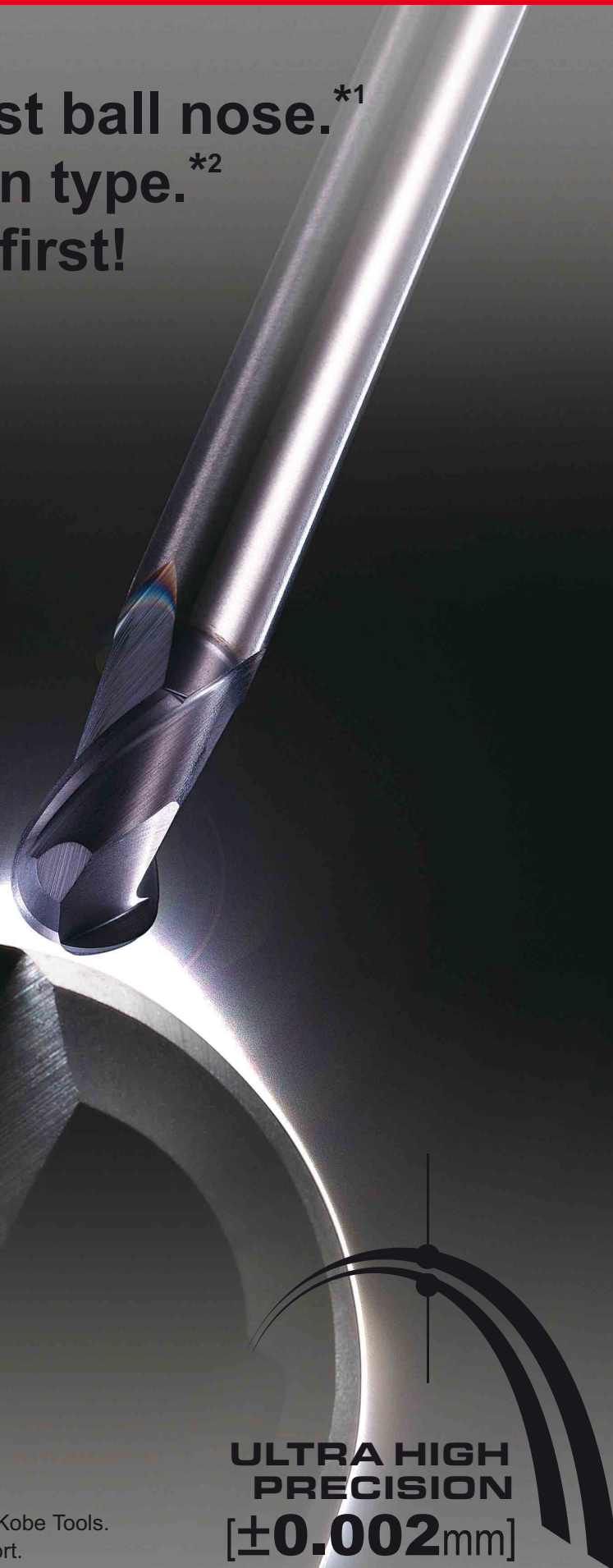
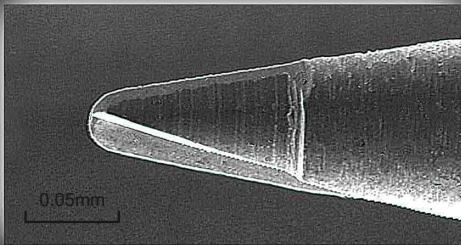


Expansion

Miracle high precision ball nose end mills

# MIRACLE NOVA

The worlds smallest ball nose.\*1  
Ultra high precision type.\*2  
R0.02mm, a world first!



**ULTRA HIGH  
PRECISION**  
**[±0.002mm]**

\*1) According to a survey by Mitsubishi Materials Kobe Tools.  
\*2) VC2PSB-P type. Supplied with inspection report.

HIGH PRECISION BALL NOSE END MILLS

# MIRACLE NOVA

Ultimate choice for high precision finishing of moulds!

ULTRA HIGH  
PRECISION  
[±0.002mm]



Ultra high radial tolerance ±2μm !!

## Newly developed R0.02 type

● Advanced grinding technology enables a commercially available R0.02mm ball nose end mill.



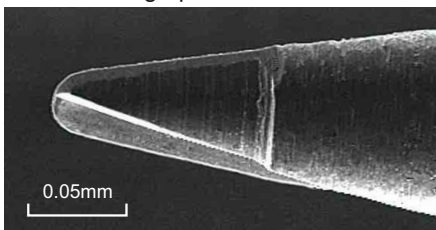
### VC-2PSB-P

(Radial tolerance ±2μm type) with inspection report

### VC-2PSB

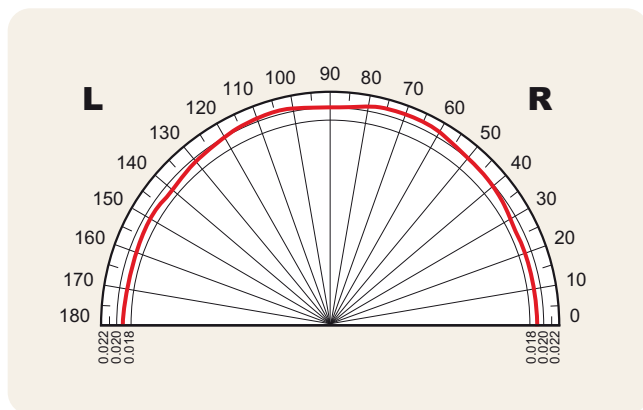
(Radial tolerance ±6μm type)

Photo macrograph R0.02



★With inspection report

■ Sample inspection report R0.02mm (VC2PSB-P)



## Inspection report (For radial tolerance ±2μm type)

● Inspection reports supplied with each high accuracy end mill.

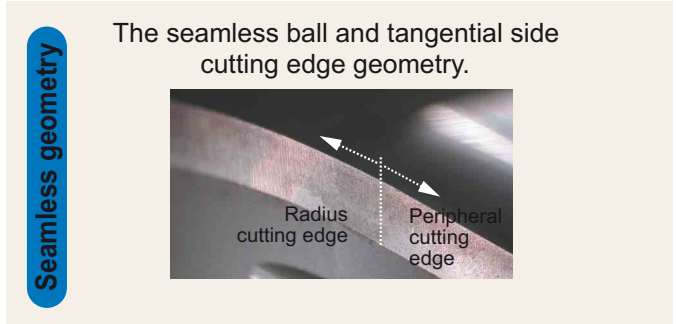


# Features

Ideal surface finishes achieved with the precision geometry and superior coating technology.

## High Precision

- Tolerance combination. The highest radial tolerance ( $\pm 2\mu\text{m}$ ) & diameter tolerance ( $0-10\mu\text{m}$ ) with a shank tolerance of h5. Ideal surface finishes achieved by the sharp cutting edge and seamless edge geometry.



## MIRACLE coating with increased lubricity.

Patent registered

- Lubricating elements added to the existing MIRACLE hard coating.

### Coating properties comparison

	Hardness (HV)	Oxidation temperature (°C)	Adhesion (N)	Friction coefficient (800°C)
<b>MIRACLE NOVA</b>	<b>3,100</b>	<b>1,100</b>	<b>100</b>	<b>0.42</b>
(Al,Ti)N	2,800	840	80	0.53

#### Adhesion :

Measured by the critical load scratch test

#### Coefficient of friction :

Measured by ball-on-disc method

#### Counter gear :

SKD61 (52HRC)

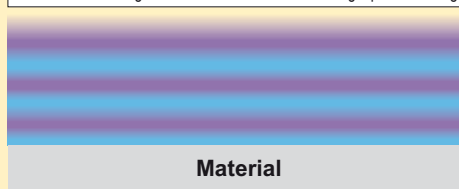
### Coating

#### MIRACLE NOVA coating

① A world first advanced coating technique that forms hard and lubricating elements in a continuous single phase coating.

② MIRACLE NOVA coating for long tool life and consistent, precision tool geometry when compared to conventional (Al,Ti)N coating.

Hard and lubricating elements within a continuous single phase coating.



Material

\* Representative drawing

Hard element

#### Improved wear resistance

High resistance to wear and heat due to the superior film hardness and oxidation resistance.

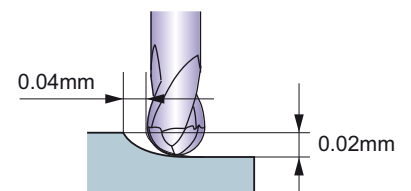
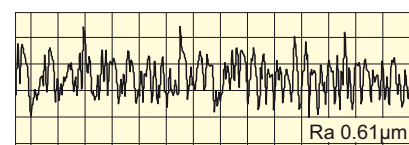
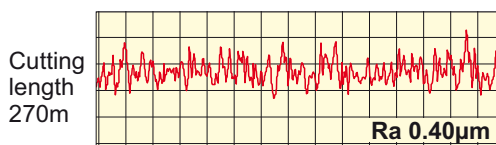
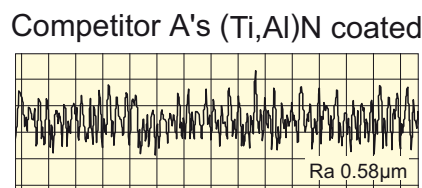
Lubricating element

#### Reduced welding

High welding resistance due to the reduced friction coefficient during cutting.

## Machining Example

- Prolonged tool life and ideal surface finish!

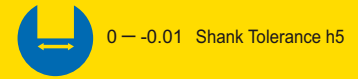


End mill	VC-2PSB R0.4
Work material	W.Nr. 1.2344 (H13) (52HRC)
Revolution	18,000mm <sup>-1</sup>
Feed rate	1,500mm/min
Cutting method	Climb cutting, Air blow

# MIRACLE END MILLS

## VC2PSB-P MIRACLE NOVA Expansion

Ball nose slot drill, Short cut length, 2 flute, Ultra high precision



VC-2PSB-P type (supplied with inspection report.)



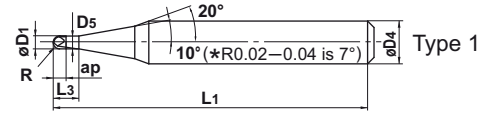
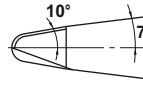
R<0.5

0.5≤R

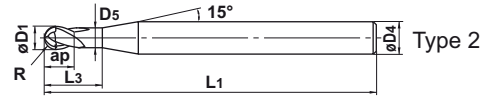
R<0.5

0.5≤R

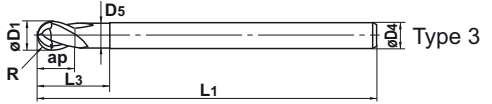
R0.02—R0.04  
point shape



Type 1



Type 2



Type 3

Unit : mm

- MIRACLE NOVA, radial tolerance of  $\pm 0.002\text{mm}$  and diameter tolerance  $0 - -0.01\text{mm}$  with a shank tolerance of h5.

Order Number	Radius of Ball Nose R	Dia. D1	Length of Cut ap	Neck Length L3	Neck Dia. D5	Overall Length L1	Shank Dia. D4	No. of Flutes N	Stock	Type
* VC2PSBPR0002	0.02	—	0.06	—	—	50	6	2	<input type="checkbox"/>	1
* R0003	0.03	—	0.09	—	—	50	6	2	<input type="checkbox"/>	1
* R0004	0.04	—	0.12	—	—	50	6	2	<input type="checkbox"/>	1
R0005	0.05	0.1	0.2	—	—	50	6	2	<input checked="" type="checkbox"/>	1
R0010	0.1	0.2	0.2	0.5	0.17	50	6	2	<input checked="" type="checkbox"/>	1
R0015	0.15	0.3	0.3	0.8	0.27	50	6	2	<input checked="" type="checkbox"/>	1
R0020	0.2	0.4	0.4	1	0.36	50	6	2	<input checked="" type="checkbox"/>	1
R0025	0.25	0.5	0.5	1.3	0.46	50	6	2	<input checked="" type="checkbox"/>	1
R0030	0.3	0.6	0.6	1.5	0.56	50	6	2	<input checked="" type="checkbox"/>	1
R0035	0.35	0.7	0.7	1.8	0.66	50	6	2	<input checked="" type="checkbox"/>	1
R0040	0.4	0.8	0.8	2	0.76	50	6	2	<input checked="" type="checkbox"/>	1
R0045	0.45	0.9	0.9	2.3	0.86	50	6	2	<input checked="" type="checkbox"/>	1
R0050	0.5	1	1.5	2.5	0.94	50	6	2	<input checked="" type="checkbox"/>	2
R0060	0.6	1.2	1.8	3	1.14	50	6	2	<input checked="" type="checkbox"/>	2
R0070	0.7	1.4	2.1	3.5	1.34	50	6	2	<input checked="" type="checkbox"/>	2
R0075	0.75	1.5	2.3	3.8	1.44	50	6	2	<input checked="" type="checkbox"/>	2
R0080	0.8	1.6	2.4	4	1.54	50	6	2	<input checked="" type="checkbox"/>	2
R0090	0.9	1.8	2.7	4.5	1.74	50	6	2	<input checked="" type="checkbox"/>	2
R0100	1	2	3	5	1.9	50	6	2	<input checked="" type="checkbox"/>	2
R0150	1.5	3	4.5	7.5	2.9	70	6	2	<input checked="" type="checkbox"/>	2
R0200	2	4	6	10	3.9	70	6	2	<input checked="" type="checkbox"/>	2
R0250	2.5	5	7.5	12.5	4.9	80	6	2	<input checked="" type="checkbox"/>	2
R0300	3	6	9	15	5.85	80	6	2	<input checked="" type="checkbox"/>	3
R0400	4	8	12	20	7.85	90	8	2	<input checked="" type="checkbox"/>	3
R0500	5	10	15	25	9.7	100	10	2	<input checked="" type="checkbox"/>	3
R0600	6	12	18	30	11.7	110	12	2	<input checked="" type="checkbox"/>	3

\*Expansion



# VC2PSB MIRACLE NOVA

Ball nose slot drill, Short cut length, 2 flute, High precision



±0.005



0 - -0.01 Shank Tolerance h5



R < 0.5



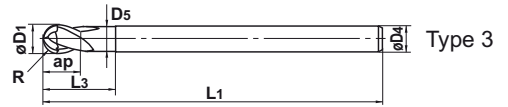
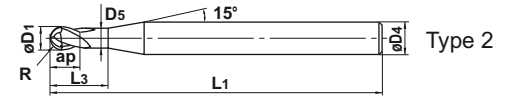
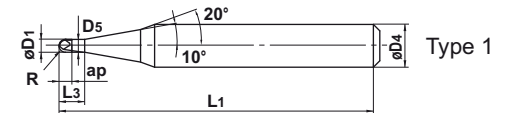
0.5 ≤ R



R < 0.5



0.5 ≤ R



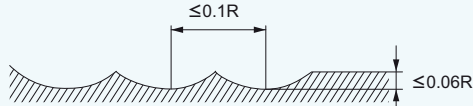
Unit : mm

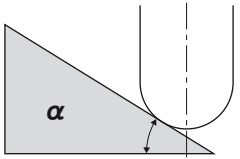
- MIRACLE NOVA, radial tolerance of ±0.002mm and diameter tolerance 0 - -0.01mm with a shank tolerance of h5.

Order Number	Radius of ball nose R	Dia. D1	Length of Cut ap	Neck Length L3	Neck Dia. D5	Overall Length L1	Shank Dia. D4	No. of Flutes N	Stock	Type
VC2PSBR0005	0.05	0.1	0.2	—	—	50	6	2	●	1
R0010	0.1	0.2	0.2	0.5	0.17	50	6	2	●	1
R0015	0.15	0.3	0.3	0.8	0.27	50	6	2	●	1
R0020	0.2	0.4	0.4	1	0.36	50	6	2	●	1
R0025	0.25	0.5	0.5	1.3	0.46	50	6	2	●	1
R0030	0.3	0.6	0.6	1.5	0.56	50	6	2	●	1
R0035	0.35	0.7	0.7	1.8	0.66	50	6	2	●	1
R0040	0.4	0.8	0.8	2	0.76	50	6	2	●	1
R0045	0.45	0.9	0.9	2.3	0.86	50	6	2	●	1
R0050	0.5	1	1.5	2.5	0.94	50	6	2	●	2
R0060	0.6	1.2	1.8	3	1.14	50	6	2	●	2
R0070	0.7	1.4	2.1	3.5	1.34	50	6	2	●	2
R0075	0.75	1.5	2.3	3.8	1.44	50	6	2	●	2
R0080	0.8	1.6	2.4	4	1.54	50	6	2	●	2
R0090	0.9	1.8	2.7	4.5	1.74	50	6	2	●	2
R0100	1	2	3	5	1.90	50	6	2	●	2
R0150	1.5	3	4.5	7.5	2.90	70	6	2	●	2
R0200	2	4	6	10	3.90	70	6	2	●	2
R0250	2.5	5	7.5	12.5	4.90	80	6	2	●	2
R0300	3	6	9	15	5.85	80	6	2	●	3
R0400	4	8	12	20	7.85	90	8	2	●	3
R0500	5	10	15	25	9.70	100	10	2	●	3
R0600	6	12	18	30	11.70	110	12	2	●	3

Work material	Alloy steel, Tool steel, Pre-hardened steel (-45HRC) W.Nr. 1.2344 (H13), X210Cr12				Hardened steel (45-55HRC) W.Nr. 1.2344 (H13)			
	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		$\alpha \leq 15^\circ$		$\alpha > 15^\circ$	
	Revolution ( $\text{min}^{-1}$ )	Feed rate ( $\text{mm/min}$ )	Revolution ( $\text{min}^{-1}$ )	Feed rate ( $\text{mm/min}$ )	Revolution ( $\text{min}^{-1}$ )	Feed rate ( $\text{mm/min}$ )	Revolution ( $\text{min}^{-1}$ )	Feed rate ( $\text{mm/min}$ )
<b>R0.05</b>	40,000	200	—	—	40,000	170	—	—
<b>R0.1</b>	40,000	600	40,000	400	40,000	600	40,000	400
<b>R0.15</b>	40,000	900	40,000	600	40,000	900	40,000	600
<b>R0.2</b>	40,000	1,000	40,000	700	40,000	1,000	40,000	700
<b>R0.25</b>	40,000	1,500	40,000	1,000	40,000	1,500	40,000	1,000
<b>R0.3</b>	40,000	2,000	40,000	1,500	40,000	2,000	40,000	1,500
<b>R0.35</b>	40,000	2,800	40,000	2,100	40,000	2,800	37,000	1,800
<b>R0.4</b>	40,000	2,800	40,000	2,100	40,000	2,800	35,000	1,800
<b>R0.45</b>	40,000	3,200	38,000	2,200	38,000	3,000	32,000	1,800
<b>R0.5</b>	40,000	3,200	35,000	2,200	35,000	3,000	30,000	1,800
<b>R0.75</b>	40,000	3,600	30,000	2,300	32,000	3,000	25,000	1,800
<b>R1</b>	35,000	3,500	25,000	2,200	28,000	2,800	20,000	1,700
<b>R1.5</b>	30,000	3,400	23,000	2,200	24,000	2,600	16,000	1,500
<b>R2</b>	25,000	3,400	20,000	2,200	20,000	2,600	14,000	1,500
<b>R2.5</b>	23,000	3,400	17,000	2,200	18,000	2,600	12,000	1,500
<b>R3</b>	20,000	3,400	15,000	2,200	16,000	2,600	10,000	1,400
<b>R4</b>	15,000	3,000	12,500	2,000	10,000	2,000	7,500	1,200
<b>R5</b>	12,000	3,000	10,000	2,000	8,000	2,000	6,000	1,200
<b>R6</b>	10,000	2,600	8,300	1,800	6,600	1,700	5,000	1,100

Depth of cut





- 1)  $\alpha$  is the inclination of the machined surface.
- 2) Please use VC2SB or VC4MB for workpieces of 55HRC or above.
- 3) If the rigidity of the machine or the workpiece installation is very low, or chattering and noise are generated, please reduce the revolution and the feed rate proportionately. When high machining accuracy is needed, we recommend lowering the feed rate.
- 4) Cutting conditions may differ considerably due to the overhang (milling depth and neck length), depth of cut and machine tool condition. Please use the above table as a standard starting point.
- 5) VC2MDB is recommended when using an end mill with a long overhang, for deep slotting with low rigidity or high hardness material milling.
- 6) If the depth of cut is shallow, the revolution and feed rate can be increased.
- 7) When using the smallest diameters, we recommend using mist coolant.

# MITSUBISHI precision tooling for highly efficient milling of hardened materials.

## For high precision, radius end milling

### High Precision Corner Radius End Mill

#### MIRACLE ORBIT VCPSRB

- MIRACLE ORBIT high radial tolerance of  $\pm 10\mu\text{m}$ , diameter tolerance 0-  $-10\mu\text{m}$ .
- For machining walls and flat surfaces of moulds.
- Reduction of end mill inventory.  
Highly efficient, precision milling.



## Ultra high feed machining

### MIRACLE High Feed Corner Radius End Mills VCHFRB

- Newly developed cutting edge with excellent chipping resistance. Possible to cut at over 10,000 mm/min feed rate.
- Wide range of end mills. Short, long neck, taper neck and long shank types available.



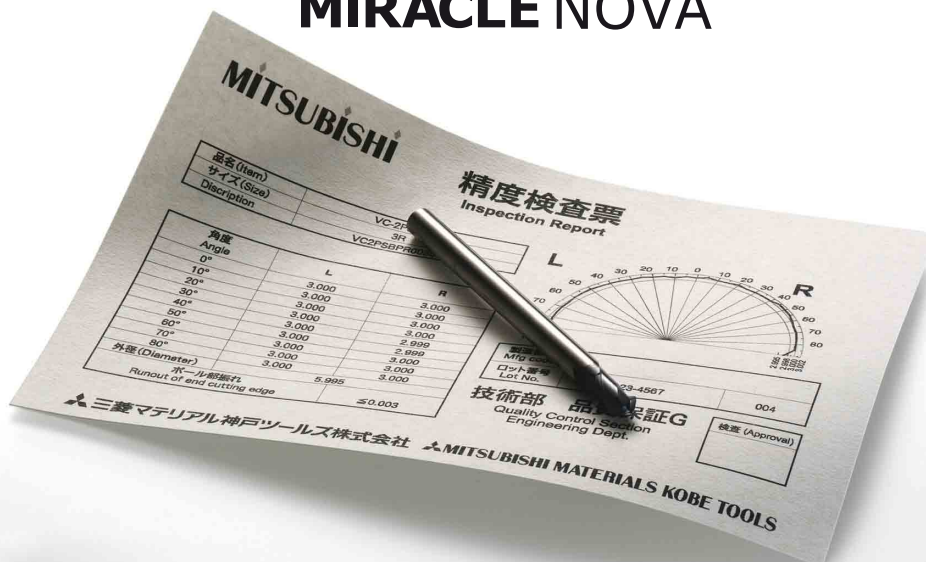
## For reliable and efficient milling of hardened materials.

### IMPACT MIRACLE End Mill Series

- Newly developed "Impact Miracle Coating".
- Improved cutting edge geometry with superior chipping resistance allows for higher speeds and reliability.



MIRACLE NOVA



**MIRACLE NOVA is manufactured in a quality controlled environment.**

**Environment**  
 Controlled manufacturing environment to improve product quality.



**Inspection**  
 Manufacture of smaller and more sophisticated cutting tools relies on the use of precision measurement technology to ensure accuracy and reliability.

**Technology**  
 Advanced technology enables us to provide the cutting tools that achieve efficient and high precision milling.



[www.mitsubishicarbide.com](http://www.mitsubishicarbide.com)

**MMC HARTMETALL GmbH**  
 Comeniusstr. 2, 40670 Meerbusch, Germany  
 Tel. +49-2159-91890 Fax +49-2159-918966  
 e-mail [marketing@mmch.de](mailto:marketing@mmch.de)

**MITSUBISHI MATERIALS ESPAÑA, S.A.**  
 C/Emperador 2, 46136 Museros, Valencia, Spain  
 Tel. +34-96-144-1711 Fax +34-96-144-3786  
 e-mail [mme@mmevalencia.com](mailto:mme@mmevalencia.com)

**MITSUBISHI HARDMETAL RUSSIA OOO LTD.**  
 ul. Bolschaja Pochtovaja, d.36, str.1 105082 Moscow, Russia  
 Tel. +007-095-72558-85 Fax +007-095-72558-85  
 e-mail [mmc-moscow@lescom.ru](mailto:mmc-moscow@lescom.ru)

**MMC HARDMETAL U.K. LTD.**  
 Mitsubishi House, Galena Close, Tamworth, B77 4AS, U.K.  
 Tel. +44-1827-312312 Fax +44-1827-312314  
 e-mail [sales@mitsubishicarbide.co.uk](mailto:sales@mitsubishicarbide.co.uk)

**MMC ITALIA S.r.l.**  
 V.le delle Industrie 20/5, 20020 Arese (Mi)  
 Tel. +39-02 93 77 03 1 Fax +39-02 93 58 90 93  
 e-mail [info@mmc-italia.it](mailto:info@mmc-italia.it)

**MMC METAL FRANCE S.A.R.L.**  
 6, rue Jacques Monod, 91893 Orsay Cedex, France  
 Tel. +33-1-69 35 53 53 Fax +33-1-69 35 53 50  
 e-mail [mmfsales@mmc-metal-france.fr](mailto:mmfsales@mmc-metal-france.fr)

**MMC HARDMETAL POLAND Sp. z o.o.**  
 Armii Karjowej 61, Wroclaw, Poland  
 Tel. +48-71-3351-620 Fax +48-71-3351-620  
 e-mail [mmc@mhpl.pl](mailto:mmc@mhpl.pl)