High performance tooling systems

GROTH Präzisionstechnik

Abplanalp TOOLS

Vollhartmetallfräser

Solid carbide end mills

Aluminium Vollhartmetallfräser

Aluminium solid carbide end mills

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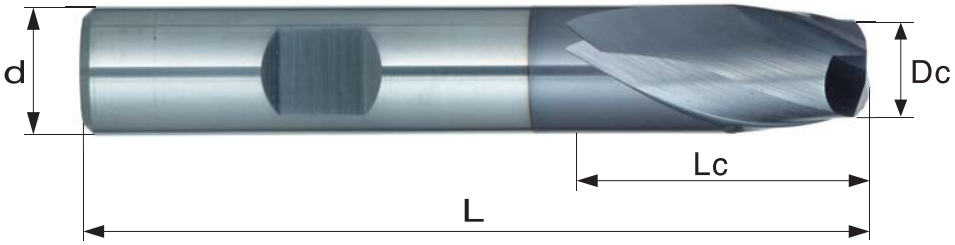
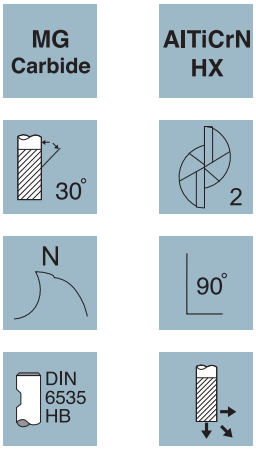
High performance tooling systems

VHM Fräser 2 Schneiden kurz

Solid carbide end mill 2 flutes short

K P H < 48 HRC





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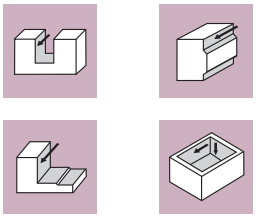

Work Material

P	H	M	K	N	S
●	●	○	●	○	

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc h6	Beschichtung Coating	Euro
F500HX020	2,0	6,0	50	2	AlTiCrN	11,00
F500HX030	3,0	6,0	50	4	AlTiCrN	11,00
F500HX040	4,0	6,0	54	5	AlTiCrN	11,00
F500HX060	6,0	6,0	54	7	AlTiCrN	11,00
F500HX080	8,0	8,0	58	9	AlTiCrN	17,00
F500HX100	10,0	10,0	66	11	AlTiCrN	25,00
F500HX120	12,0	12,0	73	12	AlTiCrN	39,00
F500HX140	14,0	14,0	75	14	AlTiCrN	57,00
F500HX160	16,0	16,0	82	16	AlTiCrN	65,00
F500HX180	18,0	18,0	84	18	AlTiCrN	93,00
F500HX200	20,0	20,0	92	20	AlTiCrN	115,00

GR.1 Non-alloyed steel
Vc.80-120 fz.

GR.2 < 24HRC Low-alloyed Steel
Vc.80-120 fz.

GR.3 < 30HRC Hi-alloyed Steel
Vc.60-100 fz.

GR.4 30~38HRC Hardened Steel
Vc.40-80 fz.

GR.5 38~48HRC Hardened Steel
Vc.30-60 fz.

GR.8 Stainless Steel
Vc.40-60 fz.

GR.9 Cast Iron
Vc.100-140 fz.

GR.11 Copper
Vc.120-180 fz.

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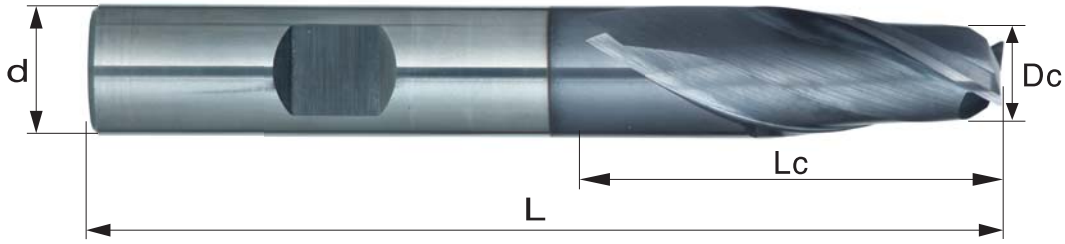
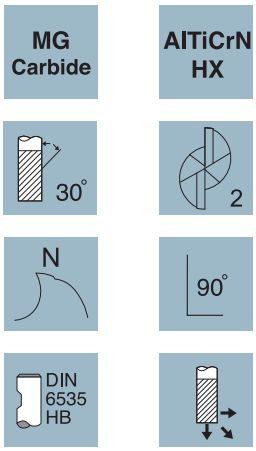
VHM Schaftfräser 2 Schneiden lang

Solid carbide end mill 2 flutes long

K P H < 48 HRC





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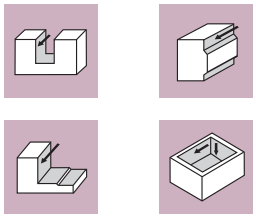

Work Material

P	H	M	K	N	S
●	●	○	●	○	

GR.1	Non-alloyed steel	Vc.80-120 fz.
GR.2	< 24HRC Low-alloyed Steel	Vc.80-120 fz.
GR.3	< 30HRC Hi-alloyed Steel	Vc.60-100 fz.
GR.4	30~38HRC Hardened Steel	Vc.40-80 fz.
GR.5	38~48HRC Hardened Steel	Vc.30-60 fz.
GR.8	Stainless Steel	Vc.40-60 fz.
GR.9	Cast Iron	Vc.100-140 fz.
GR.11	Copper	Vc.120-180 fz.

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc mm	Beschichtung Coating	Euro
F501HX0300	3	6	57	7	AlTiCrN	11,00
F501HX0400	4	6	57	8	AlTiCrN	11,00
F501HX0600	6	6	57	10	AlTiCrN	11,00
F501HX0800	8	8	63	16	AlTiCrN	18,00
F501HX1000	10	10	72	19	AlTiCrN	28,00
F501HX1200	12	12	83	22	AlTiCrN	42,00
F501HX1400	14	14	83	22	AlTiCrN	63,00
F501HX1600	16	16	92	26	AlTiCrN	72,00
F501HX1800	18	18	92	26	AlTiCrN	103,00
F501HX2000	20	20	104	32	AlTiCrN	126,00

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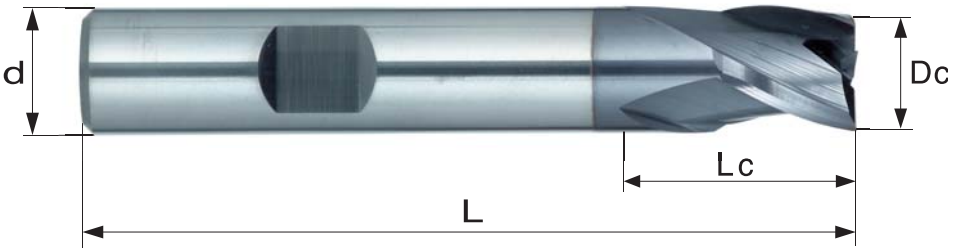
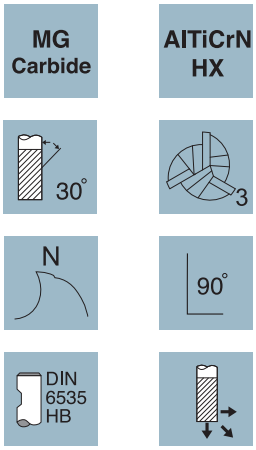
GROTH Präzisionstechnik

VHM Schaftfräser 3 Schneiden kurz

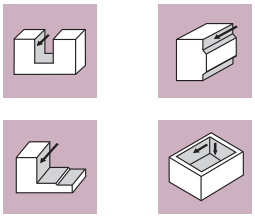
Solid carbide end mill 3 flutes short

K P H < 48 HRC





Type of Operation



- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc mm	Beschichtung Coating	Euro
F503HX060	6	6	54	7	AlTiCrN	11,00
F503HX080	8	8	58	8	AlTiCrN	17,00
F503HX100	10	10	66	10	AlTiCrN	25,00
F503HX120	12	12	73	16	AlTiCrN	39,00
F503HX140	14	14	75	19	AlTiCrN	57,00
F503HX160	16	16	82	22	AlTiCrN	65,00
F503HX180	18	18	84	22	AlTiCrN	93,00
F503HX200	20	20	92	26	AlTiCrN	115,00

Work Material

P	H	M	K	N	S
●	●	○	●	○	

GR.1 Non-alloyed steel
Vc.80-120 fz.

GR.2 < 24HRC Low-alloyed Steel
Vc.80-120 fz.

GR.3 < 30HRC Hi-alloyed Steel
Vc.60-100 fz.

GR.4 30~38HRC Hardened Steel
Vc.40-80 fz.

GR.5 38~48HRC Hardened Steel
Vc.30-60 fz.

GR.8 Stainless Steel
Vc.40-60 fz.

GR.9 Cast Iron
Vc.100-140 fz.

GR.11 Copper
Vc.120-180 fz.

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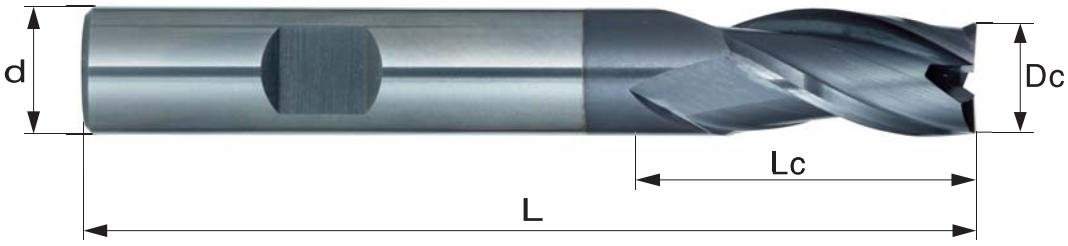
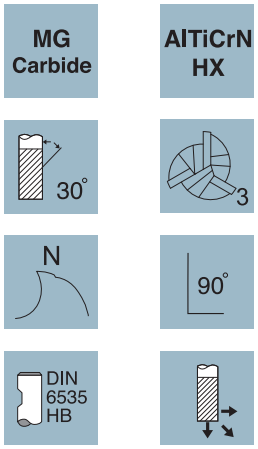
VHM Schaftfräser 3 Schneiden lang

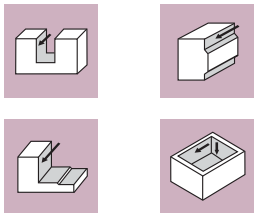
Solid carbide end mill 3 flutes long

K P H < 48 HRC





Type of Operation



Work Material

P	H	M	K	N	S
●	●	○	●	○	

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc mm	Beschichtung Coating	Euro
F504HX060	6	6	57	10	AlTiCrN	11,00
F504HX080	8	8	63	16	AlTiCrN	18,00
F504HX100	10	10	72	19	AlTiCrN	28,00
F504HX120	12	12	83	22	AlTiCrN	42,00
F504HX140	14	14	83	22	AlTiCrN	63,00
F504HX160	16	16	92	26	AlTiCrN	102,00
F504HX180	18	18	92	26	AlTiCrN	103,00
F504HX200	20	20	104	32	AlTiCrN	126,00

GR.1 Non-alloyed steel
Vc.80-120 fz.

GR.2 < 24HRC Low-alloyed Steel
Vc.80-120 fz.

GR.3 < 30HRC Hi-alloyed Steel
Vc.60-100 fz.

GR.4 30~38HRC Hardened Steel
Vc.40-80 fz.

GR.5 38~48HRC Hardened Steel
Vc.30-60 fz.

GR.8 Stainless Steel
Vc.40-60 fz.

GR.9 Cast Iron
Vc.100-140 fz.

GR.11 Copper
Vc.120-180 fz.

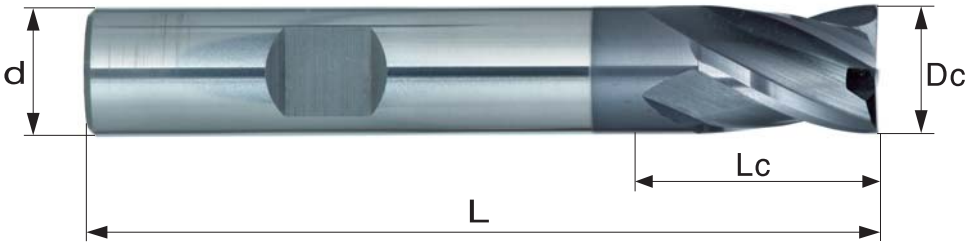
Schnittdaten Seite 10.21
Cutting datas page 10.21

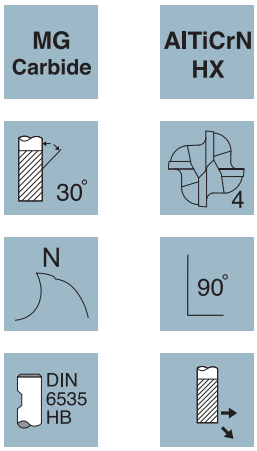
GROTH Präzisionstechnik

VHM Schaftfräser 4 Schneiden kurz

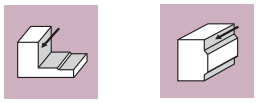
Solid carbide end mill 4 flutes short

K P H < 48 HRC





Type of Operation



Work Material

P	H	M	K	N	S
●	●	○	●	○	

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc mm	Beschichtung Coating	Euro
F506HX020	2	6	50	4	AlTiCrN	10,00
F506HX030	3	6	50	5	AlTiCrN	10,00
F506HX040	4	6	54	8	AlTiCrN	11,00
F506HX060	6	6	54	10	AlTiCrN	11,00
F506HX080	8	8	58	12	AlTiCrN	18,00
F506HX100	10	10	66	14	AlTiCrN	26,00
F506HX120	12	12	73	16	AlTiCrN	39,00
F506HX140	14	14	75	18	AlTiCrN	57,00
F506HX160	16	16	82	22	AlTiCrN	65,00
F506HX180	18	18	84	24	AlTiCrN	93,00
F506HX200	20	20	92	26	AlTiCrN	113,00

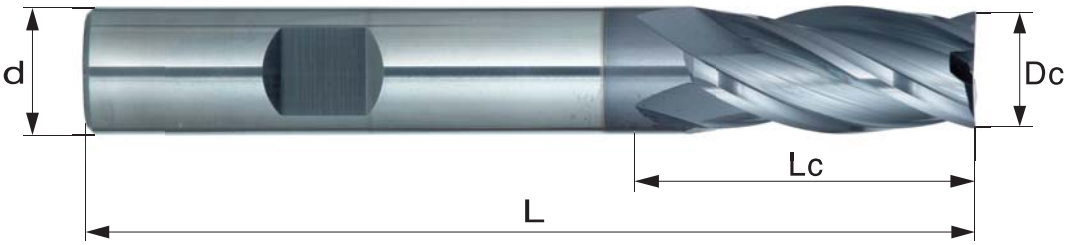
GR.1	Non-alloyed steel	Vc.80-120 fz.
GR.2	<24HRC Low-alloyed Steel	Vc.80-120 fz.
GR.3	<30HRC Hi-alloyed Steel	Vc.60-100 fz.
GR.4	30~38HRC Hardened Steel	Vc.40-80 fz.
GR.5	38~48HRC Hardened Steel	Vc.30-60 fz.
GR.8	Stainless Steel	Vc.40-60 fz.
GR.9	Cast Iron	Vc.100-140 fz.
GR.11	Copper	Vc.120-180 fz.

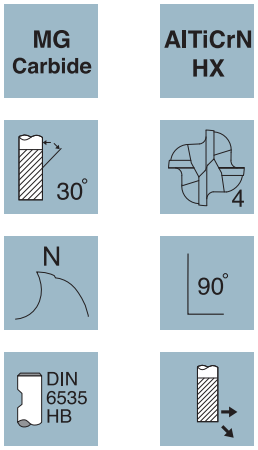
Schnittdaten Seite 10.21
Cutting datas page 10.21

VHM Schaftfräser 4 Schneiden lang

Solid carbide end mill 4 flutes long

K P H < 48 HRC



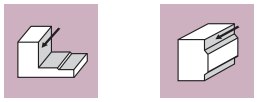


- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	L mm	Lc mm	Beschichtung Coating	Euro
F507HX030	3	6	57	8	AlTiCrN	12,00
F507HX040	4	6	57	11	AlTiCrN	12,00
F507HX060	6	6	57	13	AlTiCrN	12,00
F507HX080	8	8	63	19	AlTiCrN	18,00
F507HX100	10	10	72	22	AlTiCrN	28,00
F507HX120	12	12	83	26	AlTiCrN	43,00
F507HX140	14	14	83	26	AlTiCrN	63,00
F507HX160	16	16	92	32	AlTiCrN	72,00
F507HX180	18	18	92	32	AlTiCrN	104,00
F507HX200	20	20	104	38	AlTiCrN	126,00

Type of Operation



Work Material

P	H	M	K	N	S
●	●	○	●	○	

GR.1 Non-alloyed steel
Vc.80-120 fz.

GR.2 <24HRC Low-alloyed Steel
Vc.80-120 fz.

GR.3 <30HRC Hi-alloyed Steel
Vc.60-100 fz.

GR.4 30~38HRC Hardened Steel
Vc.40-80 fz.

GR.5 38~48HRC Hardened Steel
Vc.30-60 fz.

GR.8 Stainless Steel
Vc.40-60 fz.

GR.9 Cast Iron
Vc.100-140 fz.

GR.11 Copper
Vc.120-180 fz.

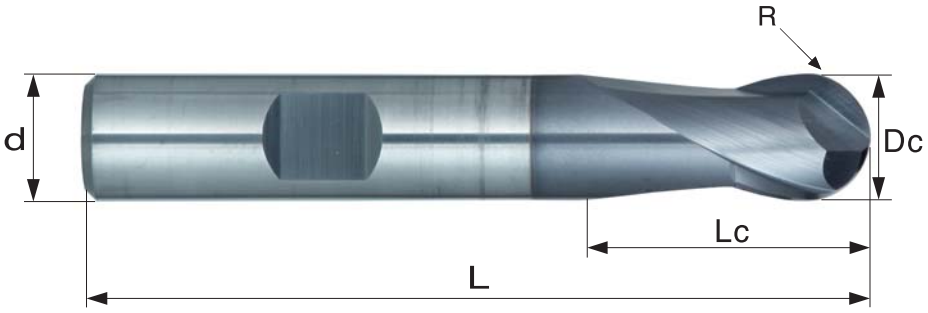
Schnittdaten Seite 10.21
Cutting datas page 10.21

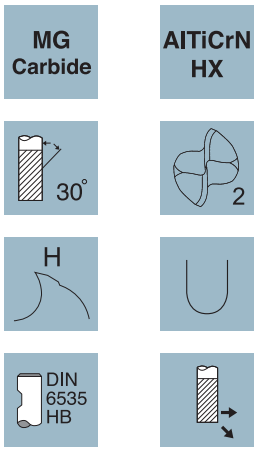
GROTH Präzisionstechnik

VHM Stirnradiusfräser 2 Schneiden kurz

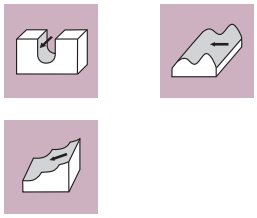
Solid carbide ball nose end mill 2 flutes short

K P H < 48 HRC





Type of Operation



- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Work Material

P	H	M	K	N	S
●	●	○	●	○	

Bestell Nr. Order no.	Dc h10	d h6	R ±0,01	L mm	Lc mm	Beschichtung Coating	Euro
F520HX020	2	6	R1,0	50	3	AlTiCrN	12,00
F520HX030	3	6	R1,5	50	4	AlTiCrN	12,00
F520HX040	4	6	R2,0	54	5	AlTiCrN	13,00
F520HX050	5	6	R2,5	54	6	AlTiCrN	13,00
F520HX060	6	6	R3,0	54	7	AlTiCrN	13,00
F520HX080	8	8	R4,0	58	9	AlTiCrN	20,00
F520HX100	10	10	R5,0	66	11	AlTiCrN	31,00
F520HX120	12	12	R6,0	73	12	AlTiCrN	45,00
F520HX140	14	14	R7,0	75	14	AlTiCrN	65,00
F520HX160	16	16	R8,0	82	16	AlTiCrN	74,00
F520HX180	18	18	R9,0	84	18	AlTiCrN	110,00
F520HX200	20	20	R10,0	92	20	AlTiCrN	131,00

GR.1 Non-alloyed steel
Vc.100-140 fz.

GR.2 < 24HRC Low-alloyed Steel
Vc.100-140 fz.

GR.3 < 30HRC Hi-alloyed Steel
Vc.80-120 fz.

GR.4 30~38HRC Hardened Steel
Vc.70-100 fz.

GR.5 38~48HRC Hardened Steel
Vc.50-80 fz.

GR.8 Stainless Steel
Vc.60-90 fz.

GR.9 Cast Iron
Vc.120-160 fz.

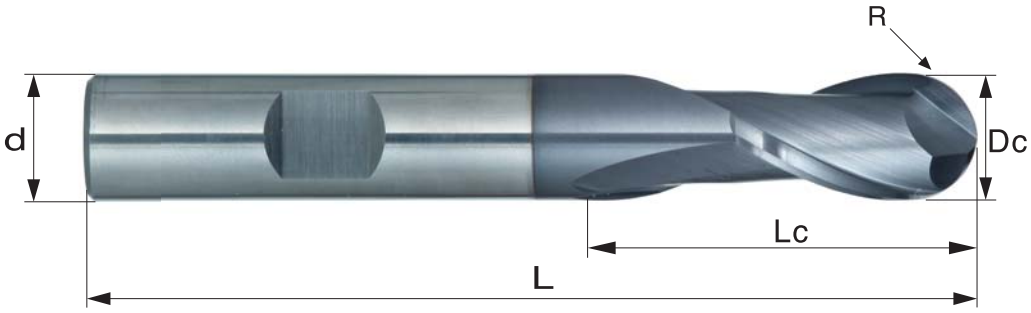
GR.11 Copper
Vc.140-200 fz.

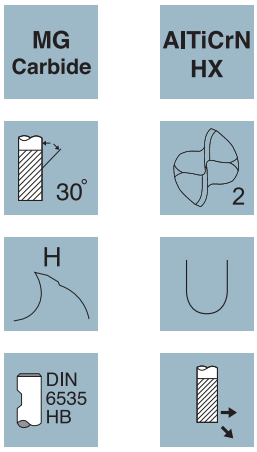
Schnittdaten Seite 10.22
Cutting datas page 10.22

VHM Stirnradiusfräser 2 Schneiden lang

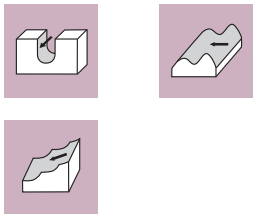
Solid carbide ball nose end mill 2 flutes long

K P H < 48 HRC





Type of Operation



Work Material

P	H	M	K	N	S
●	●	○	●	○	

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <48 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 48HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h6	R ±0,01	L mm	Lc mm	Beschichtung Coating	Euro
F521HX020	2	6	R1,0	57	6	AlTiCrN	11,00
F521HX030	3	6	R1,5	57	7	AlTiCrN	13,00
F521HX040	4	6	R2,0	57	8	AlTiCrN	13,00
F521HX050	5	6	R2,5	57	10	AlTiCrN	13,00
F521HX060	6	6	R3,0	57	10	AlTiCrN	13,00
F521HX080	8	8	R4,0	63	16	AlTiCrN	21,00
F521HX100	10	10	R5,0	72	19	AlTiCrN	34,00
F521HX120	12	12	R6,0	83	22	AlTiCrN	49,00
F521HX140	14	14	R7,0	83	22	AlTiCrN	75,00
F521HX160	16	16	R8,0	92	26	AlTiCrN	85,00
F521HX180	18	18	R9,0	92	26	AlTiCrN	125,00
F521HX200	20	20	R10,0	104	32	AlTiCrN	153,00

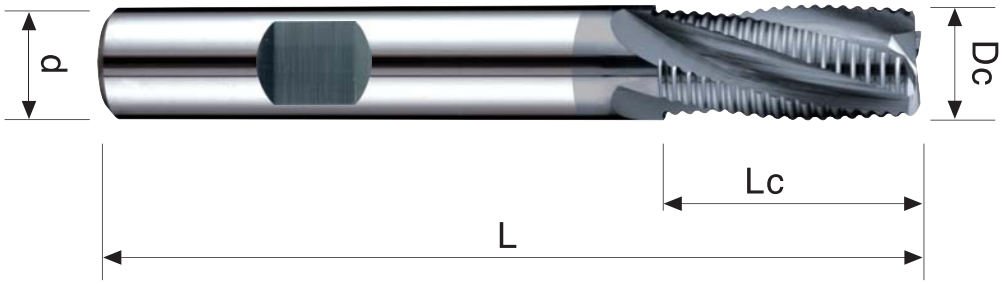
GR.1	Non-alloyed steel
	Vc.100-140 fz.
GR.2	< 24HRC Low-alloyed Steel
	Vc.100-140 fz.
GR.3	< 30HRC Hi-alloyed Steel
	Vc.80-120 fz.
GR.4	30~38HRC Hardened Steel
	Vc.70-100 fz.
GR.5	38~48HRC Hardened Steel
	Vc.50-80 fz.
GR.8	Stainless Steel
	Vc.60-90 fz.
GR.9	Cast Iron
	Vc.120-160 fz.
GR.11	Copper
	Vc.140-200 fz.

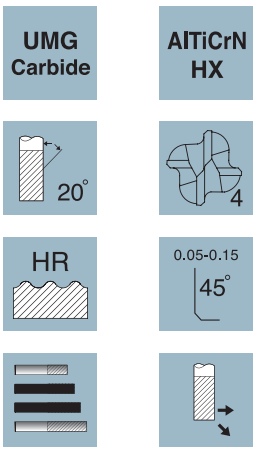
Schnittdaten Seite 10.22
Cutting datas page 10.22

VHM Feinstkorn Schruppfräser

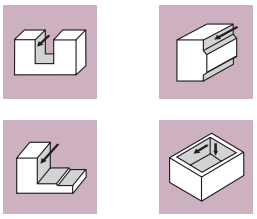
UMG Solid carbide rouging end mill

K P H < 56HRC





Type of Operation



Work Material

P	H	M	K	N	S
●	●		●		○

- **Beschichtung: AlTiCrN**
- **Ausgezeichnete Hochleistungsfräser**
- **Zur Bearbeitung von Werkstoffen bis <56 HRC**
- **Zylinderschaft nach DIN 6535 HB**

- Coating: AlTiCrN
- Excellent high-performance end mills
- For processing material < 56HRC
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h5	L mm	Lc mm	Z	Beschichtung Coating	Euro
F508HX-DC060	6	6	57	13	3	AlTiCrN	19,00
F508HX-DC080	8	8	63	19	3	AlTiCrN	29,00
F508HX-DC100	10	10	72	22	4	AlTiCrN	46,00
F508HX-DC120	12	12	83	26	4	AlTiCrN	61,00
F508HX-DC140	14	14	83	26	4	AlTiCrN	84,00
F508HX-DC160	16	16	92	32	4	AlTiCrN	112,00
F508HX-DC180	18	18	92	32	4	AlTiCrN	147,00
F508HX-DC200	20	20	104	38	4	AlTiCrN	179,00

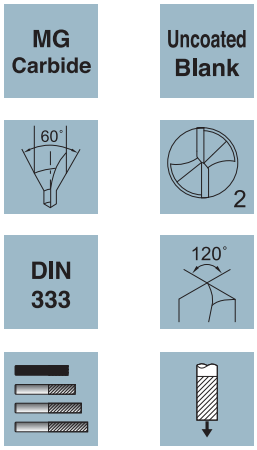
GR.1	Non-alloyed steel
Vc.100-120	
GR.2	<24HRC Low-alloyed Steel
Vc.100-120	
GR.3	<30HRC Hi-alloyed Steel
Vc.60-80	
GR.4	30~38HRC Hardened Steel
Vc.40-60	
GR.5	38~48HRC Hardened Steel
Vc.30-40	
GR.6	48~56HRC Hardened Steel
Vc.20-30	
GR.9	Cast Iron
Vc.120-160	
GR.15	Titanium
Vc.30-40	

Schnittdaten Seite 10.24
Cutting datas page 10.24

Vollhartmetall Zentrierbohrer 60°

Solid carbide center drill and countersink 60°

K P H < 48 HRC



Work Material

P	H	M	K	N	S
●	●	○	●	○	

GR.1 Non-alloyed steel
Vc.30-40 f.

GR.2 <24HRC Low-alloyed Steel
Vc.30-40 f.

GR.3 <30HRC Hi-alloyed Steel
Vc.20-30 f.

GR.4 30~38HRC Hardened Steel
Vc.10-20 f.

GR.5 38~48HRC Hardened Steel
Vc.10-20 f.

GR.8 Stainless Steel
Vc.15-25 f.

GR.9 Cast Iron
Vc.40-50 f.

GR.10 Aluminium
Vc.80-100 f.

GR.11 Copper
Vc.60-80 f.

Bestell Nr. Order no.	Dc h7	d h6	L mm	Lc mm	Euro
D908-DC0.50	0,50	3	38	0,8	13,00
D908-DC0.80	0,80	3	38	1,1	13,00
D908-DC1.00	1,00	3	38	1,3	13,00
D908-DC1.25	1,25	3	38	1,6	14,00
D908-DC1.60	1,60	4	38	2,0	18,00
D908-DC2.00	2,00	5	50	2,5	21,00
D908-DC2.50	2,50	6	50	3,1	26,00
D908-DC3.15	3,15	8	63	3,9	32,00
D908-DC4.00	4,00	10	66	5,0	41,00
D908-DC5.00	5,00	12	73	6,3	56,00

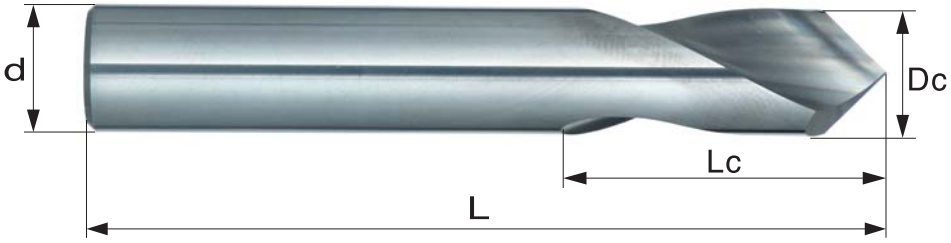
Schnittdaten Seite 10.23
Cutting datas page 10.23

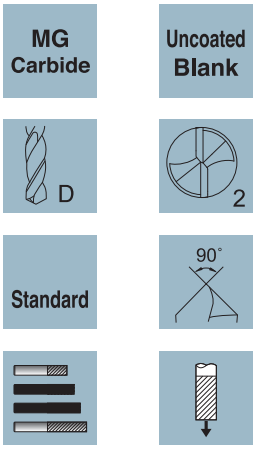
GROTH Präzisionstechnik

Vollhartmetall NC Anbohrer 90°

Solid carbide NC spot drill 90°

K P H < 48 HRC





Work Material

P	H	M	K	N	S
●	●	○	●	○	○

GR.1 Non-alloyed steel
Vc.50-60 f.

GR.2 < 24HRC Low-alloyed Steel
Vc.50-60 f.

GR.3 < 30HRC Hi-alloyed Steel
Vc.40-50 f.

GR.4 30~38HRC Hardened Steel
Vc.40-50 f.

GR.5 38~48HRC Hardened Steel
Vc.30-40 f.

GR.8 Stainless Steel
Vc.20-30 f.

GR.9 Cast Iron
Vc.60-70 f.

GR.11 Copper
Vc.80-100 f.

GR.15 Titanium
Vc.20-40 f.

GR.16 Nickel
Vc.15-20 f.

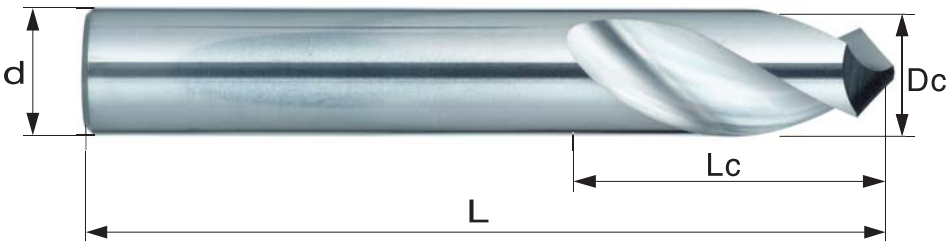
Bestell Nr. Order no.	Dc h6	d h6	L mm	Lc mm	Euro
D903-DC040	4	4	50	12	9,00
D903-DC060	6	6	60	20	10,00
D903-DC080	8	8	60	25	18,00
D903-DC100	10	10	72	25	26,00
D903-DC120	12	12	75	30	38,00
D903-DC160	16	16	100	35	77,00
D903-DC200	20	20	100	40	122,00

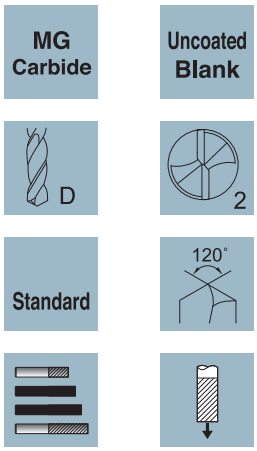
Schnittdaten Seite 10.23
Cutting datas page 10.23

Vollhartmetall NC Anbohrer 120°

Solid carbide NC spot drill 120°

K P H < 48 HRC





Work Material

P	H	M	K	N	S
●	●	○	●	○	○

GR.1 Non-alloyed steel
Vc.50-60 f.

GR.2 <24HRC Low-alloyed Steel
Vc.50-60 f.

GR.3 <30HRC Hi-alloyed Steel
Vc.40-50 f.

GR.4 30~38HRC Hardened Steel
Vc.40-50 f.

GR.5 38~48HRC Hardened Steel
Vc.30-40 f.

GR.8 Stainless Steel
Vc.20-30 f.

GR.9 Cast Iron
Vc.60-70 f.

GR.11 Copper
Vc.80-100 f.

GR.15 Titanium
Vc.20-40 f.

GR.16 Nickel
Vc.15-20 f.

Bestell Nr. Order no.	Dc h6	d h6	L mm	Lc mm	Euro
D913-DC040	4	4	50	12	9,00
D913-DC060	6	6	60	20	10,00
D913-DC080	8	8	60	25	18,00
D913-DC100	10	10	72	25	26,00
D913-DC120	12	12	75	30	38,00
D913-DC160	16	16	100	35	77,00
D913-DC200	20	20	100	40	122,00

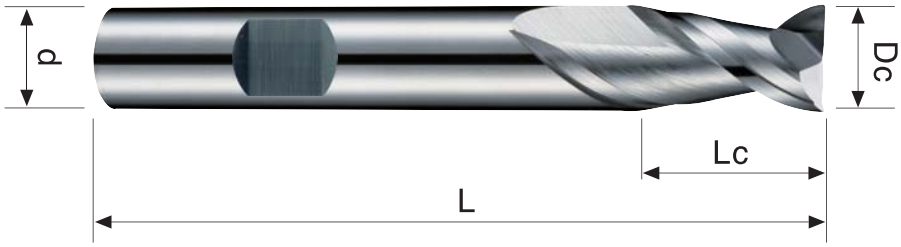
Schnittdaten Seite 10.23
Cutting datas page 10.23

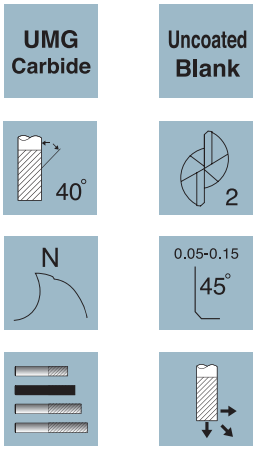
GROTH Präzisionstechnik

Aluminium Feinstkorn VHM Fräser 2 Schneiden

Aluminium UMG solid carbide end mill 2 flutes

N Aluminium

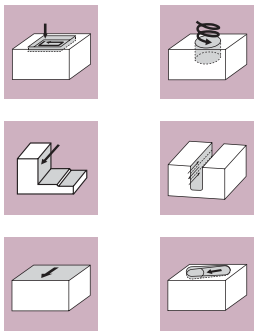




- **Ausgezeichnete Hochleistungsfräser**
- **Zylinderschaft nach DIN 6535 HB**

- Excellent high-performance end mills
- For weldon shanks after DIN 6535 HB

Type of Operation



Work Material

P	H	M	K	N	S
				●	

GR.10 Aluminium
Vc.300-800

GR.11 Copper
Vc.200-600

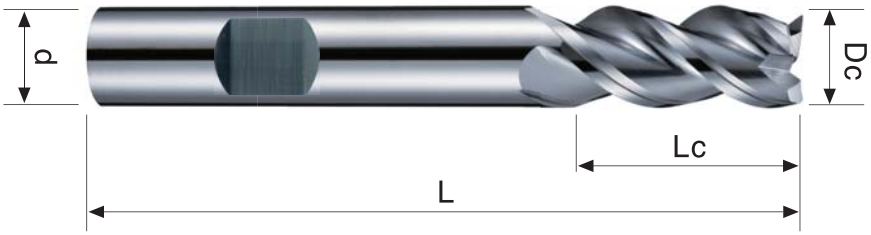
Bestell Nr. Order no.	Dc h10	d h5	L mm	Lc mm	Euro
F600-DC030	3	6	57	7	12,00
F600-DC040	4	6	57	8	12,00
F600-DC050	5	6	57	10	12,00
F600-DC060	6	6	57	10	12,00
F600-DC080	8	8	63	16	18,00
F600-DC100	10	10	72	19	29,00
F600-DC120	12	12	83	22	39,00

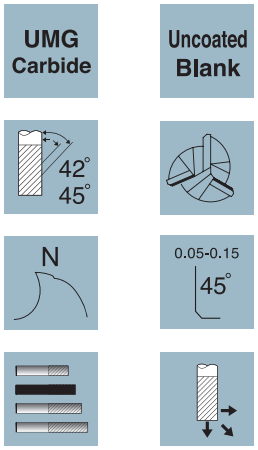
Schnittdaten Seite 10.24
Cutting datas page 10.24

Aluminium Feinstkorn VHM Fräser 3 Schneiden

Aluminium UMG solid carbide end mill 3 flutes

N Aluminium



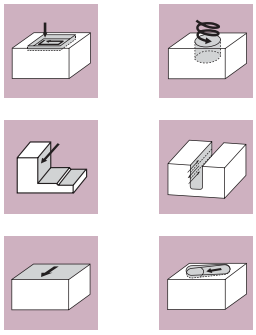


- **Ausgezeichnete Hochleistungsfräser**
- **Zylinderschaft nach DIN 6535 HB**

- Excellent high-performance end mills
- For weldon shanks after DIN 6535 HB

Bestell Nr. Order no.	Dc h10	d h5	L mm	Lc mm	Euro
F631-DC030	3	6	57	8	14,00
F631-DC040	4	6	57	11	14,00
F631-DC050	5	6	57	13	14,00
F631-DC060	6	6	57	13	14,00
F631-DC080	8	8	63	19	21,00
F631-DC100	10	10	72	22	34,00
F631-DC120	12	12	83	26	47,00

Type of Operation



Work Material

P	H	M	K	N	S
				●	

GR.10 Aluminium
Vc.300-800

GR.11 Copper
Vc.300-600

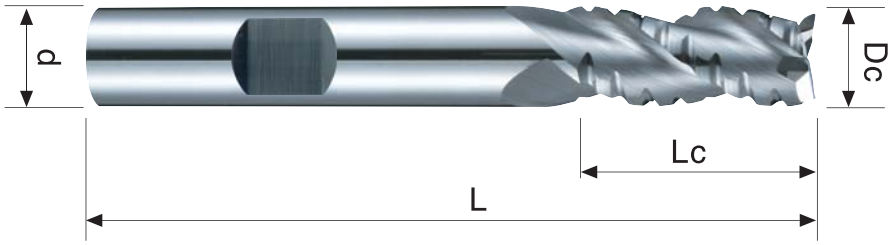
Schnittdaten Seite 10.24
Cutting datas page 10.24

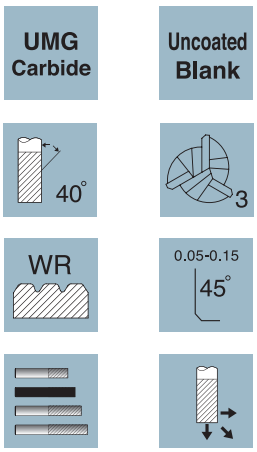
GROTH Präzisionstechnik

Aluminium Feinstkorn VHM Schruppfräser 3 Schneiden

Aluminium UMG solid carbide roughing end mill 3 flutes

N Aluminium

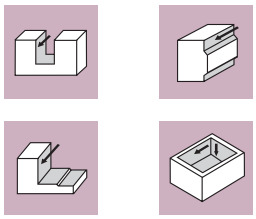




- **Ausgezeichnete Hochleistungsschruppfräser**
- **Zylinderschaft nach DIN 6535 HB**

- Excellent high-performance end mills
- For weldon shanks after DIN 6535 HB

Type of Operation



Work Material

P	H	M	K	N	S
				●	

GR.10 Aluminium
Vc.200-450

GR.11 Copper
Vc.100-300

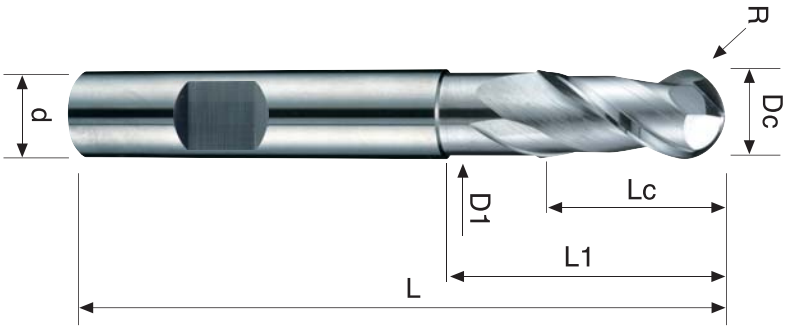
Bestell Nr. Order no.	Dc h10	d h5	L mm	Lc mm	Euro
F642-DC060	6	6	57	13	18,00
F642-DC080	8	8	63	19	28,00
F642-DC100	10	10	72	22	43,00
F642-DC120	12	12	83	26	58,00
F642-DC160	16	16	92	32	110,00
F642-DC200	20	20	104	38	173,00

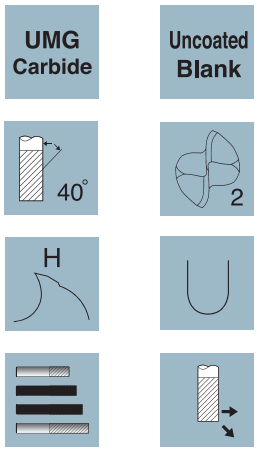
Schnittdaten Seite 10.24
Cutting datas page 10.24

Aluminium Feinstkorn VHM Stirnradiusfräser 2 Schneiden

Aluminium UMG Solid carbide ball nose end mill 2 flutes

N Aluminium

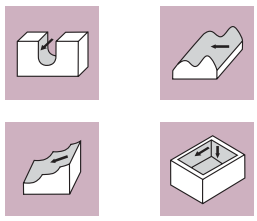




- **Ausgezeichnete Hochleistungsfräser**
- **Zylinderschaft nach DIN 6535 HB**

- Excellent high-performance end mills
- For weldon shanks after DIN 6535 HB

Type of Operation



Work Material

P	H	M	K	N	S
				●	

GR.10 Aluminium
Vc.400-800

GR.11 Copper
Vc.300-600

Bestell Nr. Order no.	Dc h10	d h5	R ±0,01	L mm	Lc mm	L1 mm	D1 mm	Euro
F618-DC030	3	6	R1,5	57	6	9	2,8	17,00
F618-DC040	4	6	R2,0	57	8	12	3,7	17,00
F618-DC050	5	6	R2,5	57	10	15	4,6	17,00
F618-DC060	6	6	R3,0	57	12	20	5,5	17,00
F618-DC080	8	8	R4,0	63	16	26	7,4	24,00
F618-DC100	10	10	R5,0	72	20	31	9,2	38,00
F618-DC120	12	12	R6,0	83	24	37	11,0	53,00

Schnittdaten Seite 10.25
Cutting datas page 10.25

GROTH Präzisionstechnik

Schnittdaten
Cutting datas

VHM Fräser 2 Schneiden
Solid carbide end mill 2 flutes

	Materials Groups		N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Stahl Non-alloyed steel	≦700	≦210	0.005/0.006	0.01-0.011	0.014-0.017	0.022-0.026	0.028-0.033	0.037-0.045	0.048-0.058	0.063-0.075	0.082-0.087	0.1-0.13
	GR.2	Stahl <24 HRC Low-alloyed steel	700-1000	210-300	0.005/0.006	0.01-0.011	0.014-0.017	0.022-0.026	0.028-0.033	0.037-0.045	0.048-0.058	0.063-0.075	0.082-0.087	0.1-0.13
	GR.3	Stahl <30 HRC Hi-alloyed steel	＞1000	＞300	0.00-0.005	0.007-0.009	0.011-0.014	0.016-0.02	0.021-0.027	0.028-0.035	0.035-0.045	0.048-0.058	0.065-0.075	0.08-0.1
H	GR.4	Stahl 30-38 HRC Hardened steel			0.00-0.005	0.007-0.009	0.011-0.014	0.016-0.02	0.021-0.027	0.028-0.035	0.035-0.045	0.048-0.058	0.065-0.075	0.08-0.1
	GR.5	Stahl 38-48 HRC Hardened steel			0.003	0.005	0.007	0.01	0.014	0.019	0.025	0.032	0.042	0.05
	GR.6	Stahl 48-56 HRC Hardened steel			0.002	0.003	0.005	0.007	0.09	0.012	0.016	0.02	0.03	0.04
	GR.7	Stahl 56-68 HRC Hardened steel			0.001	0.002	0.004	0.005	0.007	0.009	0.012	0.016	0.02	0.03
M	GR.8	Edelstahl Stainless steel	500~950	250~320	0.003-0.005	0.007-0.01	0.01-0.014	0.014-0.021	0.019-0.028	0.026-0.037	0.033-0.048	0.043-0.063	0.055-0.082	0.08-0.11
K	GR.9	Gusseisen Cast iron		180-280	0.004-0.006	0.008-0.011	0.012-0.017	0.017-0.025	0.022-0.033	0.03-0.045	0.039-0.058	0.051-0.075	0.067-0.097	0.09-0.13
N	GR.10	Aluminium Aluminium		Si 0.5~12%	0.004-0.006	0.008-0.011	0.013-0.016	0.018-0.023	0.025-0.032	0.035-0.045	0.042-0.055	0.055-0.071	0.072-0.092	0.09-0.12
	GR.11	Kupfer Copper		180=250	0.003-0.006	0.006-0.011	0.009-0.016	0.014-0.023	0.018-0.031	0.025-0.042	0.032-0.055	0.041-0.071	0.055-0.092	0.07-0.12
	GR.12	Plastik Plastic			0.005	0.01	0.015	0.022	0.029	0.04	0.052	0.068	0.087	0.11
	GR.13	Gusswerkstoffe Composite material			0.005	0.01	0.015	0.022	0.029	0.04	0.052	0.068	0.087	0.11
	GR.14	Graphit Graphite			0.005-0.007	0.006-0.09	0.009-0.013	0.014-0.021	0.032-0.04	0.048-0.07	0.072-0.11	0.087-0.13	0.11-0.16	0.14-0.21
S	GR.15	Titanium Titanium	700~1250	210~370	0.003-0.005	0.006-0.01	0.009-0.015	0.013-0.022	0.017-0.029	0.023-0.04	0.03-0.051	0.039-0.067	0.051-0.087	0.07-0.012
	GR.16	Nickel Nickel	900~1200	260~350	0.003-0.004	0.005-0.008	0.008-0.013	0.012-0.018	0.016-0.024	0.021-0.033	0.027-0.042	0.035-0.055	0.046-0.072	0.06-0.09
	GR.17	Hitzeresistenter Stahl Heat resistant steel	900-1400	210-400	0.003-0.004	0.007-0.008	0.01-0.013	0.014-0.018	0.019-0.024	0.026-0.033	0.033-0.042	0.043-0.055	0.056-0.072	0.08-0.1

Schnittdaten
Cutting datas

VHM Fräser 3+4 Schneiden
Solid carbide end mill 3+4 flutes

	Materials Groups		N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Stahl Non-alloyed steel	≦700	≦210	0.006~0.008	0.011-0.013	0.016-0.019	0.023-0.028	0.03-0.04	0.045-0.055	0.055-0.065	0.075-0.085	0.08-0.09	0.12-0.14
	GR.2	Stahl <24 HRC Low-alloyed steel	700-1000	210-300	0.006~0.008	0.011-0.013	0.016-0.019	0.023-0.028	0.03-0.04	0.045-0.055	0.055-0.065	0.075-0.085	0.08-0.09	0.12-0.14
	GR.3	Stahl <30 HRC Hi-alloyed steel	＞1000	＞300	0.005-0.007	0.009-0.011	0.014-0.017	0.022-0.026	0.026-0.037	0.037-0.052	0.05-0.06	0.07-0.08	0.07-0.08	0.1-0.12
H	GR.4	Stahl 30-38 HRC Hardened steel			0.005-0.007	0.009-0.011	0.014-0.017	0.022-0.026	0.026-0.037	0.037-0.052	0.05-0.06	0.07-0.08	0.07-0.08	0.1-0.12
	GR.5	Stahl 38-48 HRC Hardened steel			0.006	0.008	0.009	0.012	0.016	0.022	0.03	0.04	0.05	0.06
	GR.6	Stahl 48-56 HRC Hardened steel			0.004	0.005	0.007	0.01	0.013	0.017	0.02	0.03	0.04	0.05
	GR.7	Stahl 56-68 HRC Hardened steel			0.002	0.004	0.005	0.007	0.009	0.011	0.015	0.02	0.03	0.04
M	GR.8	Edelstahl Stainless steel	500~950	250~320	0.005-0.01	0.01-0.015	0.013-0.017	0.017-0.024	0.022-0.032	0.03-0.04	0.04-0.05	0.047-0.055	0.05-0.06	0.08-0.13
K	GR.9	Gusseisen Cast iron		180-280	0.006-0.009	0.011-0.016	0.017-0.022	0.022-0.03	0.029-0.036	0.037-0.055	0.052-0.063	0.06-0.08	0.07-0.09	0.12-0.15
N	GR.10	Aluminium Aluminium		Si 0.5~12%	0.006-0.009	0.012-0.03	0.018-0.025	0.023-0.033	0.03-0.04	0.04-0.06	0.06-0.07	0.062-0.083	0.08-0.11	0.13-0.2
	GR.11	Kupfer Copper		180=250	0.005-0.009	0.001-0.03	0.015-0.024	0.02-0.03	0.025-0.035	0.03-0.05	0.04-0.06	0.055-0.075	0.06-0.08	0.07-0.18
	GR.12	Plastik Plastic			0.007	0.012	0.017	0.025	0.032	0.045	0.06	0.07	0.095	0.13
	GR.13	Gusswerkstoffe Composite material			0.007	0.012	0.017	0.025	0.032	0.045	0.06	0.07	0.095	0.13
	GR.14	Graphit Graphite			0.007-0.01	0.01-0.013	0.012-0.017	0.016-0.02	0.035-0.045	0.055-0.075	0.08-0.12	0.1-0.15	0.12-0.17	0.16-0.23
S	GR.15	Titanium Titanium	700~1250	210~370	0.005-0.007	0.008-0.013	0.012-0.017	0.015-0.025	0.02-0.032	0.03-0.045	0.038-0.05	0.045-0.07	0.065-0.094	0.08-0.13
	GR.16	Nickel Nickel	900~1200	260~350	0.004-0.006	0.007-0.01	0.01-0.015	0.014-0.022	0.018-0.028	0.025-0.04	0.03-0.045	0.04-0.06	0.06-0.08	0.07-0.1
	GR.17	Hitzeresistenter Stahl Heat resistant steel	900-1400	210-400	0.005-0.0065	0.008-0.011	0.011-0.016	0.015-0.024	0.02-0.03	0.03-0.044	0.033-0.048	0.04-0.065	0.063-0.09	0.1-0.12

GROTH Präzisionstechnik

Schnittdaten
Cutting datas

VHM Stirnradiusfräser 2 Schneiden
Solid carbide ball nose end mill 2 flutes

	Materials Groups		N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Stahl Non-alloyed steel	≦700	≦210	0.01~0.012	0.02~0.022	0.026~0.03	0.037~0.041	0.062~0.066	0.1~0.11	0.11~0.126	0.12~0.14	0.16~0.18	0.18~0.2
	GR.2	Stahl <24 HRC Low-alloyed steel	700-1000	210-300	0.01~0.012	0.02~0.022	0.026~0.03	0.037~0.041	0.062~0.066	0.1~0.11	0.11~0.126	0.12~0.14	0.16~0.18	0.18~0.2
	GR.3	Stahl <30 HRC Hi-alloyed steel	＞1000	＞300	0.008~0.01	0.018~0.02	0.026~0.028	0.035~0.039	0.059~0.063	0.08~0.09	0.09~0.11	0.1~0.12	0.14~0.16	0.16~0.18
H	GR.4	Stahl 30-38 HRC Hardened steel			0.008~0.01	0.018~0.02	0.026~0.028	0.035~0.039	0.059~0.063	0.08~0.09	0.09~0.11	0.1~0.12	0.14~0.16	0.16~0.18
	GR.5	Stahl 38-48 HRC Hardened steel			0.005~0.008	0.009~0.012	0.015~0.019	0.03~0.034	0.048~0.052	0.079~0.083	0.094~0.098	0.09~0.116	0.12~0.14	0.14~0.16
	GR.6	Stahl 48-56 HRC Hardened steel			0.006	0.01	0.016	0.028	0.046	0.07	0.088	0.1	0.12	0.13
	GR.7	Stahl 56-68 HRC Hardened steel			0.005	0.009	0.012	0.02	0.04	0.06	0.07	0.08	0.1	0.11
M	GR.8	Edelstahl Stainless steel	500~950	250~320	0.005~0.008	0.009~0.012	0.015~0.019	0.03~0.034	0.048~0.052	0.079~0.083	0.094~0.098	0.09~0.116	0.12~0.14	0.14~0.16
K	GR.9	Gusseisen Cast iron		180-280	0.01~0.012	0.02~0.022	0.026~0.03	0.037~0.041	0.062~0.066	0.1~0.11	0.11~0.126	0.12~0.14	0.16~0.18	0.18~0.2
N	GR.10	Aluminium Aluminium		Si 0.5~12%	0.012~0.014	0.02~0.024	0.03~0.036	0.044~0.048	0.07~0.075	0.11~0.13	0.12~0.14	0.14~0.16	0.18~0.2	0.2~0.22
	GR.11	Kupfer Copper		180=250	0.01~0.012	0.018~0.022	0.028~0.032	0.04~0.044	0.065~0.07	0.1~0.12	0.11~0.13	0.12~0.14	0.16~0.18	0.18~0.2
	GR.12	Plastik Plastic			0.015~0.023	0.03~0.037	0.05~0.065	0.06~.075	0.09~0.12	0.13~0.17	0.16~0.2	0.2~0.3	0.25~0.4	0.3~0.5
	GR.13	Gusswerkstoffe Composite material			0.015~0.023	0.03~0.037	0.05~0.065	0.06~.075	0.09~0.12	0.13~0.17	0.16~0.2	0.2~0.3	0.25~0.4	0.3~0.5
	GR.14	Graphit Graphite			0.02~0.025	0.03~0.04	0.05~0.06	0.05~0.06	0.08~0.09	0.1~0.12	0.12~0.15	0.14~0.18	0.18~0.22	0.2~0.24
S	GR.15	Titanium Titanium	700~1250	210~370	0.005~0.008	0.009~0.012	0.015~0.019	0.03~0.034	0.048~0.052	0.079~0.083	0.094~0.098	0.09~0.116	0.12~0.14	0.14~0.16
	GR.16	Nickel Nickel	900~1200	260~350	0.006~0.008	0.08~0.01	0.012~0.014	0.025~0.028	0.044~0.048	0.07~0.075	0.08~0.085	0.08~0.1	0.1~0.12	0.11~0.13
	GR.17	Hitzeresistenter Stahl Heat resistant steel	900-1400	210-400	0.006~0.008	0.08~0.01	0.012~0.014	0.025~0.028	0.044~0.048	0.07~0.075	0.08~0.085	0.08~0.1	0.1~0.12	0.11~0.13

Schnittdaten

Cutting datas

Vollhartmetall NC Anbohrer 90° + 120° Vollhartmetall Zentrierbohrer 60°

Solid carbide NC spot drill 90° + 120° Solid carbide center drill and countersink 60°

	Materials Groups		N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Stahl Non-alloyed steel	≦700	≦210	0.015~0.02	0.02~0.03	0.03~0.05	0.045~0.07	0.065~0.1	0.085~0.125	0.1~0.155	0.13~0.19	0.13~0.24	0.15~0.25
	GR.2	Stahl <24 HRC Low-alloyed steel	700-1000	210-300	0.015~0.02	0.02~0.03	0.03~0.05	0.045~0.07	0.065~0.1	0.085~0.125	0.1~0.155	0.13~0.19	0.13~0.24	0.15~0.25
	GR.3	Stahl <30 HRC Hi-alloyed steel	>1000	>300	0.01~0.016	0.016~0.02	0.025~0.03	0.035~0.045	0.05~0.06	0.065~0.08	0.08~0.1	0.1~0.12	0.12~0.15	0.14~0.2
H	GR.4	Stahl 30-38 HRC Hardened steel			0.01~0.016	0.016~0.02	0.025~0.03	0.035~0.045	0.05~0.06	0.065~0.08	0.08~0.1	0.1~0.12	0.12~0.15	0.14~0.2
	GR.5	Stahl 38-48 HRC Hardened steel			0.005	0.01	0.015	0.022	0.031	0.04	0.05	0.06	0.075	0.09
	GR.6	Stahl 48-56 HRC Hardened steel												
	GR.7	Stahl 56-68 HRC Hardened steel												
M	GR.8	Edelstahl Stainless steel	500~950	250~320	0.01~0.015	0.016~0.023	0.025~0.035	0.035~0.05	0.05~0.07	0.065~0.09	0.08~0.12	0,1~0.14	0.12~0.175	0.135~0.2
K	GR.9	Gusseisen Cast iron		180-280	0.013~0.02	0.023~0.037	0.034~0.055	0.05~0.08	0.07~0.11	0.09~0.145	0.11~0.18	0.135~0.22	0.17~0.27	0.19~0.32
N	GR.10	Aluminium Aluminium		Si 0.5~12%	0.015~0.025	0.03~0.051	0.045~0.076	0.066~0.11	0.092~0.154	0.12~0.2	0.15~0.25	0.18~0.3	0.225~0.375	0.25~0.4
	GR.11	Kupfer Copper		180=250	0.012~0.03	0.022~0.04	0.03~0.06	0.05~0.08	0.06~0.14	0.08~0.17	0.11~0.2	0.12~0.25	0.15~0.27	0.2~0.3
	GR.12	Plastik Plastic			0.01~0.02	0.02~0.024	0.03~0.036	0.044~0.052	0.062~0.073	0.08~0.095	0.1~0.12	0.12~0.15	0.15~0.18	0.16~0.2
	GR.13	Gusswerkstoffe Composite material			0.015~0.02	0.023~0.027	0.034~0.04	0.049~0.058	0.069~0.081	0.09~0.105	0.11~0.13	0.13~0.158	0.17~0.2	0.2~0.25
	GR.14	Graphit Graphite												
S	GR.15	Titanium Titanium	700~1250	210~370	0.01~0.016	0.02~0.029	0.03~0.044	0.044~0.063	0.062~0.088	0.08~0.115	0.1~0.144	0.12~0.173	0.15~0.216	0.18~0.25
	GR.16	Nickel Nickel	900~1200	260~350	0.008~0.014	0.019~0.024	0.03~0.04	0.04~0.05	0.06~0.075	0.075~0.095	0.095~0.12	0.11~0.145	0.14~0.17	0.16~0.2
	GR.17	Hitzeresistenter Stahl Heat resistant steel	900-1400	210-400	0.01~0.02	0.02~0.03	0.25~0.045	0.036~0.066	0.05~0.071	0.065~0.12	0.08~0.15	0.098~0.18	0.122~0.225	0.14~0.26

GROTH Präzisionstechnik

Schnittdaten
Cutting datas

VHM Feinstkorn Schruppfräser
UMG Solid carbide rouging end mill

Aluminium Feinstkorn VHM Fräser 2 + 3 Schneiden
Aluminium UMG solid carbide end mill 2 + 3 flutes

Aluminium Feinstkorn VHM Schruppfräser 3 Schneiden
Aluminium UMG solid carbide roughing end mill 3 flutes

	Materials Groups		N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Non-alloyed steel	≦700	≦210	0.008-0.012	0.01-0.014	0.015-0.02	0.025-0.03	0.03-0.05	0.04-0.05	0.06-0.08	0.07-0.09	0.11-0.14	0.12-0.15
P	GR.2	<24HRC Low-alloyed Steel	700-1000	210-300	0.008-0.012	0.01-0.014	0.015-0.02	0.025-0.03	0.03-0.05	0.04-0.05	0.06-0.08	0.07-0.09	0.11-0.14	0.12-0.15
P	GR.3	<30HRC Hi-alloyed Stee	＞1000	＞300	0.006-0.008	0.008-0.012	0.014-0.016	0.022-0.026	0.025-0.04	0.03-0.04	0.04-0.06	0.06-0.08	0.08-0.1	0.1-0.13
H	GR.4	30~38HRC Hardened Steel			0.006-0.008	0.008-0.012	0.014-0.016	0.022-0.026	0.025-0.04	0.03-0.04	0.04-0.06	0.06-0.08	0.08-0.1	0.1-0.13
H	GR.5	38~48HRC Hardened Steel			0.005	0.008	0.012	0.015	0.02	0.025	0.035	0.05	0.06	0.08
H	GR.6	48~56HRC Hardened Steel			0.004	0.006	0.01	0.012	0.015	0.02	0.03	0.04	0.05	0.07
H	GR.7	56~68HRC Hardened Steel			0.002	0.004	0.008	0.01	0.012	0.015	0.024	0.03	0.04	0.06
M	GR.8	Stainless Steel	500~950	250~320	0.004-0.006	0.08-0.012	0.012-0.016	0.018-0.025	0.022-0.03	0.04-0.06	0.05-0.07	0.06-0.09	0.08-0.1	0.09-0.15
K	GR.9	Cast Iron		180-280	0.08-0.011	0.01-0.016	0.015-0.025	0.025-0.035	0.03-0.065	0.04-0.08	0.06-0.09	0.08-0.11	0.09-0.012	0.11-0.16
N	GR.10	Aluminium		Si 0.5~12%	0.008-0.01	0.0015-0.02	0.018-0.025	0.02-0.04	0.03-0.06	0.04-0.07	0.05-0.08	0.06-0.09	0.08-0.12	0.1-0.15
N	GR.11	Copper		180=250	0.006-0.008	0.008-0.012	0.012-0.02	0.012-0.025	0.015-0.04	0.02-0.05	0.03-0.06	0.04-0.07	0.06-0.01	0.08-0.12
N	GR.12	Plastics			0.005-0.01	0.01-0.02	0.01-0.03	0.02-0.04	0.04-0.06	0.05-0.08	0.06-0.1	0.1-0.14	0.1-0.16	0.15-0.2
N	GR.13	FRP CFRP Composite Material			0.005-0.01	0.01-0.02	0.01-0.03	0.02-0.04	0.04-0.06	0.05-0.08	0.06-0.1	0.1-0.14	0.1-0.16	0.15-0.2
N	GR.14	Graphite			0.005-0.007	0.006-0.09	0.009-0.013	0.014-0.021	0.032-0.04	0.048-0.07	0.072-0.11	0.087-0.13	0.11-0.16	0.14-0.21
S	GR.15	Titanium	700~1250	210~370	0.005-0.007	0.008-0.012	0.011-0.017	0.015-0.024	0.019-0.031	0.025-0.05	0.03-0.05	0.04-0.07	0.06-0.09	0.08-0.013
S	GR.16	Nickel	900~1200	260~350	0.005-0.006	0.007-0.01	0.01-0.015	0.014-0.02	0.018-0.026	0.024-0.04	0.03-0.05	0.04-0.06	0.05-0.08	0.07-0.1
S	GR.17	Heat-resistant Steel	900-1400	210-400	0.005-0.006	0.009-0.01	0.012-0.015	0.016-0.02	0.021-0.026	0.028-0.035	0.035-0.05	0.05-0.06	0.06-0.085	0.09-0.12

Schnittdaten

Cutting datas

Aluminium Feinstkorn VHM Stirnradiusfräser 2 Schneiden

Aluminium UMG Solid carbide ball nose end mill 2 flutes

HSC Ap=0.03d Ae=0.05d fz= Feed Per Tooth

Materials Groups			N/mm2	HB	Ø1	Ø2	Ø3	Ø4	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20
P	GR.1	Non-alloyed steel	≦700	≦210	0.02~0.03	0.05~0.055	0.07~0.084	0.09~0.102	0.12~0.13	0.12~0.13	0.13~0.16	0.13~0.16	0.14~0.17	0.14~0.17
	GR.2	<24HRC Low-alloyed Steel	700-1000	210-300	0.02~0.03	0.05~0.055	0.07~0.084	0.09~0.102	0.12~0.13	0.12~0.13	0.13~0.16	0.13~0.16	0.14~0.17	0.14~0.17
	GR.3	<30HRC Hi-alloyed Stee	＞1000	＞300	0.02~0.03	0.05~0.055	0.07~0.084	0.09~0.102	0.12~0.13	0.12~0.13	0.13~0.16	0.13~0.16	0.14~0.17	0.14~0.17
H	GR.4	30~38HRC Hardened Steel			0.02~0.025	0.04~0.045	0.06~0.074	0.08~0.09	0.11~0.12	0.11~0.12	0.12~0.15	0.12~0.15	0.13~0.16	0.13~0.16
	GR.5	38~48HRC Hardened Steel			0.02~0.025	0.04~0.045	0.06~0.074	0.08~0.09	0.11~0.12	0.11~0.12	0.12~0.15	0.12~0.15	0.13~0.16	0.13~0.16
	GR.6	48~56HRC Hardened Steel			0.015~0.02	0.03~0.04	0.04~0.05	0.06~0.08	0.08~0.1	0.08~0.1	0.1~0.12	0.1~0.12	0.11~0.13	0.11~0.13
	GR.7	56~68HRC Hardened Steel			0.015~0.02	0.03~0.04	0.04~0.05	0.06~0.08	0.08~0.1	0.08~0.1	0.1~0.12	0.1~0.12	0.11~0.13	0.11~0.13
M	GR.8	Stainless Steel	500~950	250~320	0.02~0.025	0.04~0.045	0.06~0.074	0.08~0.09	0.11~0.12	0.11~0.12	0.12~0.15	0.12~0.15	0.13~0.16	0.13~0.16
K	GR.9	Cast Iron		180-280	0.02~0.03	0.05~0.055	0.07~0.084	0.09~0.102	0.12~0.13	0.12~0.13	0.13~0.16	0.13~0.16	0.14~0.17	0.14~0.17
N	GR.10	Aluminium		Si 0.5~12%	0.03~0.05	0.05~0.07	0.06~0.09	0.12~0.15	0.15~0.2	0.18~0.24	0.22~0.26	0.25~0.3	0.28~0.32	0.3~0.35
	GR.11	Copper		180=250	0.03~0.05	0.05~0.07	0.06~0.09	0.12~0.15	0.15~0.2	0.18~0.24	0.22~0.26	0.25~0.3	0.28~0.32	0.3~0.35
	GR.12	Plastics			0.02~0.04	0.04~0.05	0.06~0.09	0.12~0.15	0.15~0.2	0.18~0.24	0.25~0.35	0.3~0.4	0.4~0.5	0.5~0.6
	GR.13	FRP CFRP Composite Material			0.02~0.04	0.04~0.05	0.06~0.09	0.12~0.15	0.15~0.2	0.18~0.24	0.25~0.35	0.3~0.4	0.4~0.5	0.5~0.6
	GR.14	Graphite			0.04~0.08	0.06~0.08	0.1~0.12	0.1~0.13	0.15~0.18	0.2~0.23	0.24~0.28	0.26~0.3	0.3~0.33	0.32~0.36
S	GR.15	Titanium	700~1250	210~370	0.015~0.02	0.03~0.04	0.04~0.05	0.06~0.08	0.08~0.1	0.08~0.1	0.1~0.12	0.1~0.12	0.11~0.13	0.11~0.13
	GR.16	Nickel	900~1200	260~350	0.015~0.02	0.03~0.04	0.04~0.05	0.06~0.08	0.08~0.1	0.08~0.1	0.1~0.12	0.1~0.12	0.11~0.13	0.11~0.13
	GR.17	Heat-resistant Steel	900-1400	210-400	0.015~0.02	0.03~0.04	0.04~0.05	0.06~0.08	0.08~0.1	0.08~0.1	0.1~0.12	0.1~0.12	0.11~0.13	0.11~0.13

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