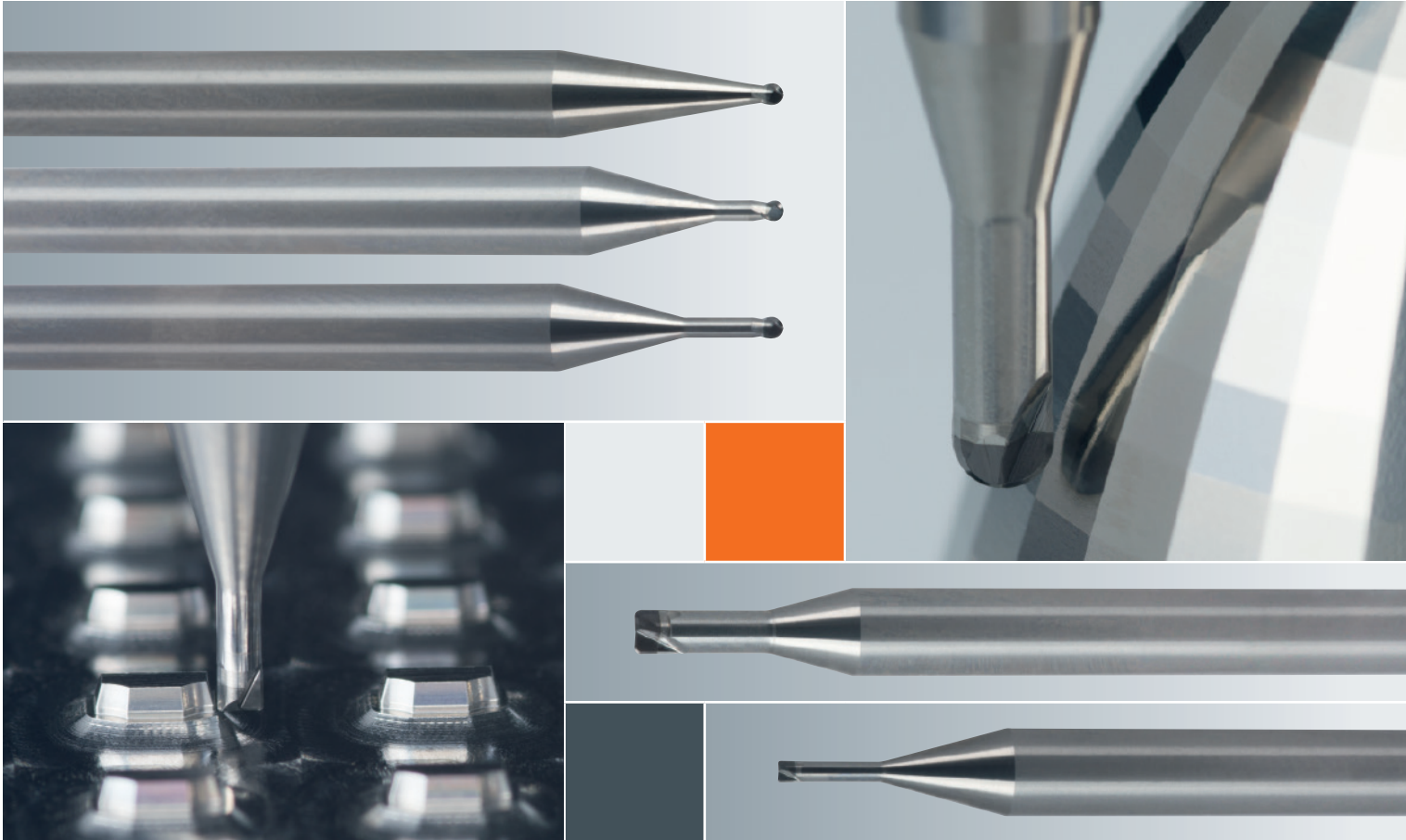




■ Made
■ in
■ Germany



Fräswerkzeuge für die Schlichtbearbeitung von gehärteten Werkstoffen
End mills for finishing of hardened materials



CBN-Fräser
CBN End Mills

Vorteile:

- Höhere Standzeiten gegenüber Hartmetall-Werkzeugen
- Sehr genaue Formtoleranzen für hochgenaue Bauteile
- Ermöglicht die Herstellung polierter Flächen durch Fräsen, keine Nacharbeit am Werkstück nötig

Einsatzgebiete:

- Gehärtete Werkstoffe bis 70 HRC
- Hochgenaue Bearbeitungen
- HSC-Schichten von 2D- und 3D-Konturen
- Bauteile mit hohen Oberflächenanforderungen

Werkzeugtypen:

- Kugel- und Torusfräser in kurzer Ausführung
- 3 Halslängen verfügbar
- Verfügbare Werkzeughalbdurchmesser 0,3 - 2,0 mm

Advantages:

- Increased tool life compared to carbide tools
- Highly accurate dimensional tolerances for high-precision parts
- Enables the production of polished surface by milling without the need for reworking the component

Applications:

- Hardened materials up to 70 HRC
- High precision machining
- For HSC finishing of 2D and 3D contours
- Components with high requirements in regard to surface quality

Types of tools:

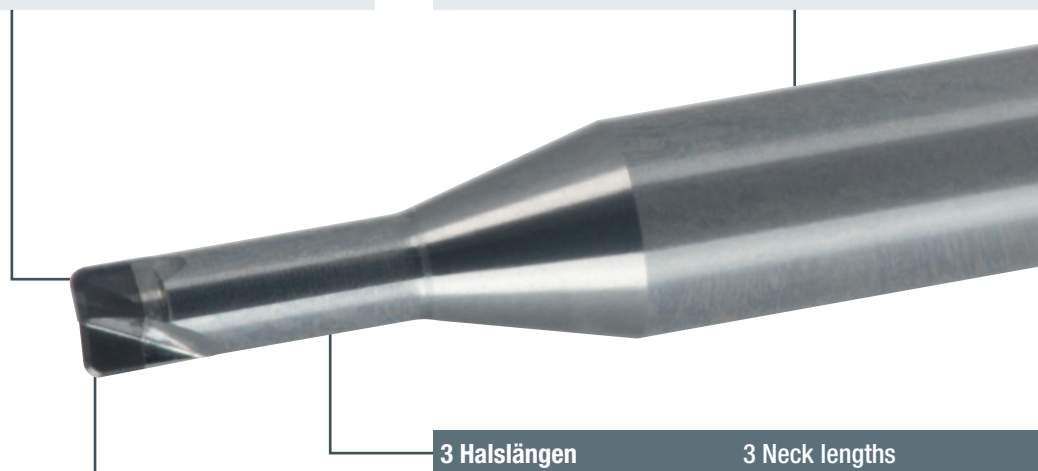
- Ball nose and torus end mills with short design
- 3 Neck lengths available
- Available tool diameters 0.3 - 2.0 mm

Torusfräser	Torus end mills
<ul style="list-style-type: none"> • Geradegenutet • Negativfase • Kurze, stabile Schneidenausführung • Verschiedene Eckenradien pro Schneiddurchmesser • Sehr genaue Formtoleranz $\pm 3 \mu\text{m}$ 	<ul style="list-style-type: none"> • Straight flutes • Negative chamfer • Short, stable cutting edge design • Various corner radii for each cutting diameter • Highly precise dimensional tolerance $\pm 3 \mu\text{m}$



Torusfräser
Torus end mills
Schneiddurchmesser 0,4 - 2,0 mm
Cutting diameter 0.4 - 2.0 mm

Schafttoleranz h4	Shank tolerance h4
<ul style="list-style-type: none"> • Hochpräzise Schäfte ermöglichen die sehr genaue Formtoleranz der Schneiden 	<ul style="list-style-type: none"> • Highly precise shanks enable highly accurate dimensional tolerance of cutting edges



Schneidstoff	Cutting material
<ul style="list-style-type: none"> • Hochleistungsschneidstoff CBN (Kubisches Bornitrid) 	<ul style="list-style-type: none"> • High-performance cutting material CBN (Cubic Boron Nitride)

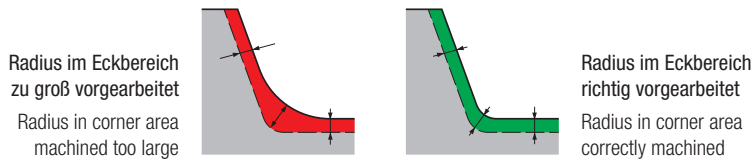
3 Halslängen	3 Neck lengths
<ul style="list-style-type: none"> • Verschieden tiefe Kavitäten können problemlos bearbeitet werden 	<ul style="list-style-type: none"> • Cavities with different depths can be machined without any problem

Anforderungen zum HSC-Schlichten mit CBN-Micro- und Mini-Kugel- und Torusfräser

- Präzisionsspannmittel mit hoher Rundlaufgenauigkeit
- Hochgenaue HSC-Bearbeitungszentren mit Spindeldrehzahlen über 25000 min⁻¹
- Um eine prozessichere und effektive Schlichtbearbeitung mit CBN-Micro- und Mini-Kugel- und Torusfräsern zu ermöglichen ist es wichtig, beim Vorschlichten auf gleichmäßiges Aufmaß des noch abzutragenden Materials zu achten. Besonders in Eckbereichen müssen die Radien entsprechend vorgearbeitet werden.

Requirement for HSC finishing with CBN micro and mini ball nose and torus end mills

- Precision clamping tool with high run-out accuracy
- Highly precise HSC machining centres with spindle speeds exceeding 25000 rpm
- In order to achieve a process-reliable and effective finishing operation with CBN micro and mini ball nose and torus end mills it is important to ensure that the machining allowance of the work piece material to be machined is even and consistent. The radii particularly in the corner areas must be premachined.



Kugelfräser	Ball nose end mill
<ul style="list-style-type: none"> • 30° gedrahlte Nuten bei Schneidendurchmesser ≤ 1,0 mm • Geradegenutet bei Schneidendurchmesser > 1,0 mm • Negativer Spanwinkel • Kurze, stabile Schneidenausführung • Sehr genaue Formtoleranz ± 3 µm 	<ul style="list-style-type: none"> • 30° spiral flutes with cutting diameter ≤ 1.0 mm • Straight flutes with cutting diameter > 1.0 mm • Negative rake angle • Short, stable cutting edge design • Highly precise dimensional tolerance ± 3 µm

Kugelfräser
Ball nose end mills

Schneidendurchmesser ≤ 1,0 mm
Cutting diameter ≤ 1.0 mm

Schneidendurchmesser > 1,0 mm
Cutting diameter > 1.0 mm

Schafttoleranz h4	Shank tolerance h4
<ul style="list-style-type: none"> • Hochpräzise Schäfte ermöglichen die sehr genaue Formtoleranz der Schneiden 	<ul style="list-style-type: none"> • Highly precise shanks enable highly accurate dimensional tolerance of cutting edges



Schneidstoff	Cutting material
<ul style="list-style-type: none"> • Hochleistungsschneidstoff CBN (Kubisches Bornitrid) 	<ul style="list-style-type: none"> • High-performance cutting material CBN (Cubic Boron Nitride)

3 Halslängen	3 Neck lengths
<ul style="list-style-type: none"> • Verschieden tiefe Kavitäten können problemlos bearbeitet werden 	<ul style="list-style-type: none"> • Cavities with different depths can be machined without any problem

- Hochleistungswerkzeug
- Verschleißfester Schneidstoff
- Schaftdurchmesser-Toleranz h4
- Stabile Schneidenausführung
- 3 Halslängen verfügbar
- High-performance tool
- Wear-resistant cutting material
- Shank diameter tolerance h4
- Stable cutting edge design
- 3 Neck lengths available

H

CBN

DIN 6535
HA
HB

Kugel

≤ 1 mm > 1 mm

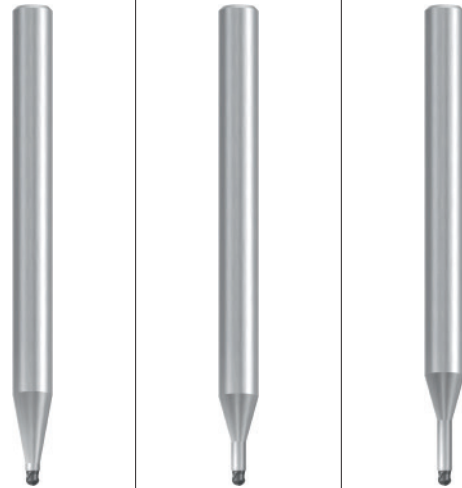
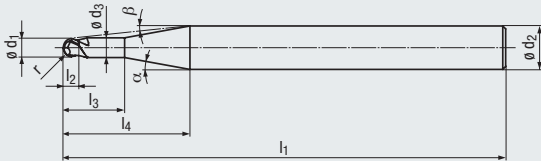
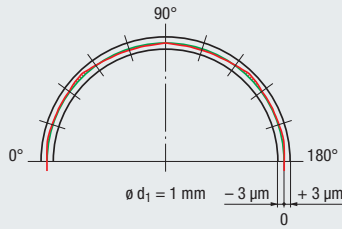
30° 0°

1-2°

V_c / f_z
5

Optional

≤ 70 HRC



Hard materials

Hard materials

Hard materials

Einsatzgebiete – Material (siehe Seite 11)

- Für hochgenaue Bearbeitungen
- Hartbearbeitung bis 70 HRC möglich
- Zum HSC-Schlichten von 2D-Konturen und 3D-Konturen mit hoher Oberflächengüte

Applications – material (see page 11)

- For high precision machining
- Hard machining possible up to 70 HRC
- For HSC finishing of 2D and 3D contours with high surface quality

K	3.1-4.2	1.1-2.2	K	3.1-4.2	1.1-2.2	K	3.1-4.2	1.1-2.2
N	2.1	2.2-2.8	N	2.1	2.2-2.8	N	2.1	2.2-2.8
H	1.1-1.5		H	1.1-1.5		H	1.1-1.5	

$l_3 = 1,5 \times d_1$

Bestell-Code · Order code												2618		
$\pm 0,006$	$\pm 0,003$										Z (Flutes)	Dimens.-Code		
0,3	0,15	0,3	0,45	50	0,27	11	4	10°	10°		2	.030	●	
0,4	0,2	0,3	0,6	50	0,36	10,9	4	10°	10°		2	.040	●	
0,5	0,25	0,35	0,75	50	0,45	10,8	4	10°	9,5°		2	.050	●	
0,8	0,4	0,6	1,2	50	0,75	10,4	4	10°	9,5°		2	.080	●	
1	0,5	0,8	1,5	50	0,95	10,1	4	10°	9°		2	.100	●	

$l_3 = 3 \times d_1$

Bestell-Code · Order code												2619		
$\pm 0,006$	$\pm 0,003$										Z (Flutes)	Dimens.-Code		
0,3	0,15	0,3	0,9	50	0,27	7,9	4	15°	14°		2	.030	●	
0,4	0,2	0,3	1,2	50	0,36	8	4	15°	13,5°		2	.040	●	
0,5	0,25	0,35	1,5	50	0,45	8,1	4	15°	13°		2	.050	●	
0,8	0,4	0,6	2,4	50	0,75	8,5	4	15°	11,5°		2	.080	●	
1	0,5	0,8	3	50	0,95	8,7	4	15°	10,5°		2	.100	●	
1,5	0,75	1,1	4,5	50	1,45	9,3	4	15°	8,5°		2	.150	●	
2	1	1,3	6	50	1,95	9,8	4	15°	7°		2	.200	●	

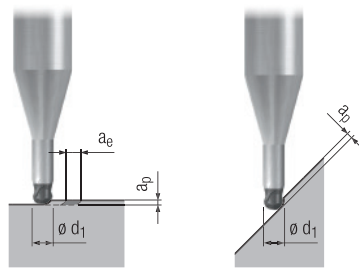
$l_3 = 4,5 \times d_1$

Bestell-Code · Order code												2620		
$\pm 0,006$	$\pm 0,003$										Z (Flutes)	Dimens.-Code		
0,3	0,15	0,3	1,35	50	0,27	8,3	4	15°	13°		2	.030	●	
0,4	0,2	0,3	1,8	50	0,36	8,6	4	15°	12,5°		2	.040	●	
0,5	0,25	0,35	2,25	50	0,45	8,9	4	15°	12°		2	.050	●	
0,8	0,4	0,6	3,6	50	0,75	9,7	4	15°	10°		2	.080	●	
1	0,5	0,8	4,5	50	0,95	10,2	4	15°	9°		2	.100	●	
1,5	0,75	1,1	6,75	50	1,45	11,5	4	15°	7°		2	.150	●	
2	1	1,3	9	50	1,95	12,8	4	15°	5°		2	.200	●	



CBN-Micro- und Mini-Kugelfräser – kurze Ausführung
CBN micro and mini ball nose end mills – short design

H



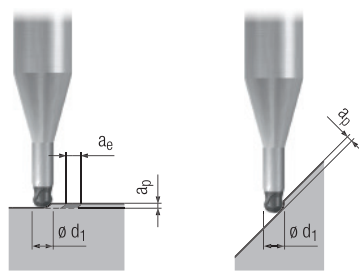
Gültig für · Valid for
2618 2619 2620

	a_p [mm]	a_e [mm]	$d_1 = 0,3 \text{ mm}$		$d_1 = 0,4 \text{ mm}$		$d_1 = 0,5 \text{ mm}$		$d_1 = 0,8 \text{ mm}$				MMS MQL		
			n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]					
Gusswerkstoffe · Cast materials															
K	1.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.1	$0,017 \times d_1$	$0,017 \times d_1$	50000	400	50000	520	50000	650	50000	1000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	$0,017 \times d_1$	$0,017 \times d_1$	50000	400	50000	520	50000	650	50000	1000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Nichteisenwerkstoffe · Non-ferrous materials															
Kupfer-Legierungen · Copper alloys															
N	2.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.3	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.4	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.5	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.6	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2.7	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
2.8	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Harte Werkstoffe · Hard materials															
H	1.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	1.3	$0,025 \times d_1$	$0,025 \times d_1$	50000	600	50000	800	50000	1000	50000	1600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	1.4	$0,017 \times d_1$	$0,017 \times d_1$	50000	400	50000	520	50000	650	50000	1000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	1.5	$0,013 \times d_1$	$0,013 \times d_1$	50000	320	50000	420	50000	530	50000	850	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>



CBN-Micro- und Mini-Kugelfräser – kurze Ausführung
CBN micro and mini ball nose end mills – short design

H



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2618 2619 2620

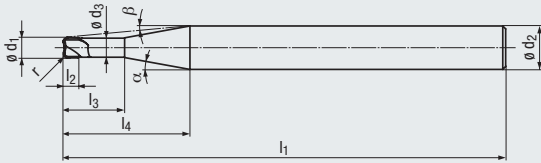
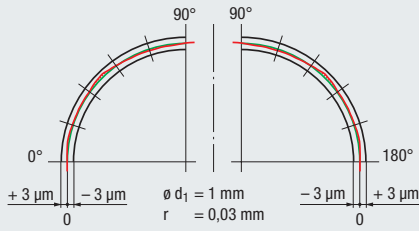
	a_p [mm]	a_e [mm]	$d_1 = 1,0 \text{ mm}$		$d_1 = 1,5 \text{ mm}$		$d_1 = 2,0 \text{ mm}$				MMS MQL	
			n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]				
Gusswerkstoffe · Cast materials												
K	1.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	3.1	$0,017 \times d_1$	$0,017 \times d_1$	50000	1300	50000	2000	40000	2100	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	3.2	$0,017 \times d_1$	$0,017 \times d_1$	50000	1300	50000	2000	40000	2100	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
4.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Nichteisenwerkstoffe · Non-ferrous materials												
Kupfer-Legierungen · Copper alloys												
N	2.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	2.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	2.3	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	2.4	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	2.5	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	2.6	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2.7	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
2.8	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	50000	4000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Harte Werkstoffe · Hard materials												
H	1.1	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	40000	3200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1.2	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	40000	3200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1.3	$0,025 \times d_1$	$0,025 \times d_1$	50000	2000	50000	3000	40000	3200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1.4	$0,017 \times d_1$	$0,017 \times d_1$	50000	1300	50000	2000	40000	2100	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	1.5	$0,013 \times d_1$	$0,013 \times d_1$	50000	1100	50000	1600	40000	1700	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

- Hochleistungswerkzeug
- Verschleißfester Schneidstoff
- Schaftdurchmesser-Toleranz h4
- Stabile Schneidenausführung
- 3 Halslängen verfügbar
- Verschiedene Eckenradien pro Schneiddurchmesser

- High-performance tool
- Wear-resistant cutting material
- Shank diameter tolerance h4
- Stable cutting edge design
- 3 Neck lengths available
- Various corner radii for each cutting diameter



Optional



Hard materials



Hard materials

Einsatzgebiete – Material (siehe Seite 11)

- Für hochgenaue Bearbeitungen
- Hartbearbeitung bis 70 HRC möglich
- Zum HSC-Schlichten von 2D-Konturen und 3D-Konturen mit hoher Oberflächengüte

Applications – material (see page 11)

- For high precision machining
- Hard machining possible up to 70 HRC
- For HSC finishing of 2D and 3D contours with high surface quality

K	3.1-4.2	1.1-2.2	K	3.1-4.2	1.1-2.2
N	2.1	2.2-2.8	N	2.1	2.2-2.8
H	1.1-1.5		H	1.1-1.5	

l₃ = 1,5 x d₁

Bestell-Code · Order code													2638		
∅ d ₁	r	l ₂	l ₃	l ₁	∅ d ₃	l ₄	∅ d ₂	α	β	Z	Dimens.-Code				
±0,006	±0,003						h4			(Flutes)					
0,4	0,03	0,3	0,6	50	0,36	10,9	4	10°	9,5°	2	.040030	●			
0,4	0,05	0,3	0,6	50	0,36	10,9	4	10°	9,5°	2	.040050	●			
0,4	0,1	0,3	0,6	50	0,36	10,9	4	10°	9,5°	2	.040100	●			
0,5	0,03	0,35	0,75	50	0,45	10,8	4	10°	9,5°	2	.050030	●			
0,5	0,05	0,35	0,75	50	0,45	10,8	4	10°	9,5°	2	.050050	●			
0,5	0,1	0,35	0,75	50	0,45	10,8	4	10°	9,5°	2	.050100	●			
1	0,03	0,8	1,5	50	0,95	10,1	4	10°	8,5°	2	.100030	●			
1	0,05	0,8	1,5	50	0,95	10,1	4	10°	8,5°	2	.100050	●			
1	0,1	0,8	1,5	50	0,95	10,1	4	10°	9°	2	.100100	●			
1	0,2	0,8	1,5	50	0,95	10,1	4	10°	9°	2	.100200	●			

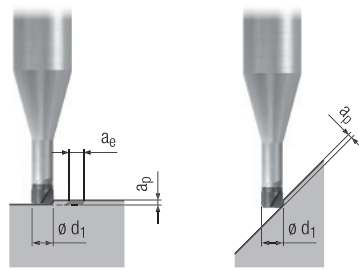
l₃ = 3 x d₁

Bestell-Code · Order code													2639		
∅ d ₁	r	l ₂	l ₃	l ₁	∅ d ₃	l ₄	∅ d ₂	α	β	Z	Dimens.-Code				
±0,006	±0,003						h4			(Flutes)					
0,4	0,03	0,3	1,2	50	0,36	8	4	15°	13°	2	.040030	●			
0,4	0,05	0,3	1,2	50	0,36	8	4	15°	13°	2	.040050	●			
0,4	0,1	0,3	1,2	50	0,36	8	4	15°	13°	2	.040100	●			
0,5	0,03	0,35	1,5	50	0,45	8,1	4	15°	12,5°	2	.050030	●			
0,5	0,05	0,35	1,5	50	0,45	8,1	4	15°	12,5°	2	.050050	●			
0,5	0,1	0,35	1,5	50	0,45	8,1	4	15°	12,5°	2	.050100	●			
1	0,03	0,8	3	50	0,95	8,7	4	15°	10°	2	.100030	●			
1	0,05	0,8	3	50	0,95	8,7	4	15°	10°	2	.100050	●			
1	0,1	0,8	3	50	0,95	8,7	4	15°	10°	2	.100100	●			
1	0,2	0,8	3	50	0,95	8,7	4	15°	10,5°	2	.100200	●			
1,5	0,1	1,1	4,5	50	1,45	9,3	4	15°	8°	2	.150100	●			
1,5	0,2	1,1	4,5	50	1,45	9,3	4	15°	8°	2	.150200	●			
1,5	0,3	1,1	4,5	50	1,45	9,3	4	15°	8°	2	.150300	●			
2	0,1	1,3	6	50	1,95	9,8	4	15°	6°	2	.200100	●			
2	0,2	1,3	6	50	1,95	9,8	4	15°	6°	2	.200200	●			
2	0,3	1,3	6	50	1,95	9,8	4	15°	6°	2	.200300	●			



CBN-Micro- und Mini-Torusfräser – kurze Ausführung
CBN micro and mini torus end mills – short design

H



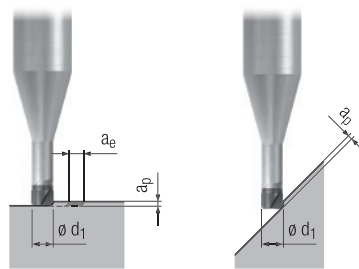
Gültig für · Valid for
2638 2639 2640

	d ₁ = 0,4 mm				d ₁ = 0,5 mm							
	a _p [mm]	a _e [mm]	n [min ⁻¹]	V _f [mm/min]	n [min ⁻¹]	V _f [mm/min]						
Gusswerkstoffe · Cast materials												
K	1.1	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.1	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.1	0,012 x d ₁	0,125 x d ₁	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	0,012 x d ₁	0,125 x d ₁	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.1	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nichteisenwerkstoffe · Non-ferrous materials												
Kupfer-Legierungen · Copper alloys												
N	2.1	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.3	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.4	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.5	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.6	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.7	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.8	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Harte Werkstoffe · Hard materials												
H	1.1	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.3	0,015 x d ₁	0,175 x d ₁	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4	0,012 x d ₁	0,125 x d ₁	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.5	0,010 x d ₁	0,100 x d ₁	50000	350	50000	450	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



CBN-Micro- und Mini-Torusfräser – kurze Ausführung
CBN micro and mini torus end mills – short design

H



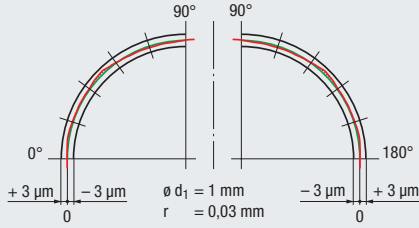
Gültig für · Valid for
2638 2639 2640

	d ₁ = 1,0 mm				d ₁ = 1,5 mm				d ₁ = 2,0 mm								
	a _p [mm]	a _e [mm]	n [min ⁻¹]	V _f [mm/min]	n [min ⁻¹]	V _f [mm/min]	n [min ⁻¹]	V _f [mm/min]									
Gusswerkstoffe · Cast materials																	
K	1.1	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.1	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.1	0,012 x d ₁	0,125 x d ₁	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	0,012 x d ₁	0,125 x d ₁	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.1	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nichteisenwerkstoffe · Non-ferrous materials																	
Kupfer-Legierungen · Copper alloys																	
N	2.1	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.3	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.4	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.5	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.6	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.7	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.8	0,015 x d ₁	0,175 x d ₁	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Harte Werkstoffe · Hard materials																	
H	1.1	0,015 x d ₁	0,175 x d ₁	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	0,015 x d ₁	0,175 x d ₁	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.3	0,015 x d ₁	0,175 x d ₁	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4	0,012 x d ₁	0,125 x d ₁	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.5	0,010 x d ₁	0,100 x d ₁	32000	800	21000	550	16000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



- Hochleistungswerkzeug
- Verschleißfester Schneidstoff
- Schaftdurchmesser-Toleranz h4
- Stabile Schneidenausführung
- 3 Halslängen verfügbar
- Verschiedene Eckenradien pro Schneiddurchmesser

- High-performance tool
- Wear-resistant cutting material
- Shank diameter tolerance h4
- Stable cutting edge design
- 3 Neck lengths available
- Various corner radii for each cutting diameter



H

CBN

DIN 6535
HA
HB

Torus

0° **1-2°**

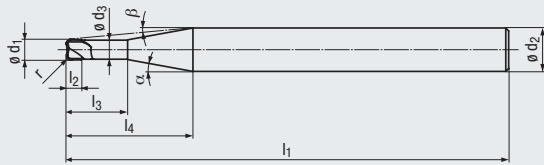
v_c / f_z
9

Optional

≤ 70 HRC



Hard materials



Einsatzgebiete – Material (siehe Seite 11)

- Für hochgenaue Bearbeitungen
- Hartbearbeitung bis 70 HRC möglich
- Zum HSC-Schlichten von 2D-Konturen und 3D-Konturen mit hoher Oberflächengüte

Applications – material (see page 11)

- For high precision machining
- Hard machining possible up to 70 HRC
- For HSC finishing of 2D and 3D contours with high surface quality

K	3.1-4.2	1.1-2.2
N	2.1	2.2-2.8
H	1.1-1.5	

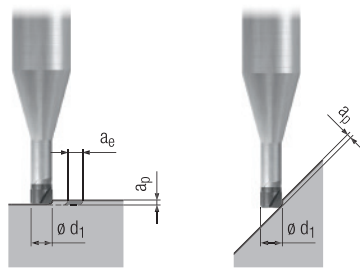
$l_3 = 4,5 \times d_1$

Bestell-Code · Order code													2640	
$\varnothing d_1$	r	l_2	l_3	l_1	$\varnothing d_3$	l_4	$\varnothing d_2$	α	β	Z	Dimens.-Code			
$\pm 0,006$	$\pm 0,003$						h4			(Flutes)				
0,4	0,03	0,3	1,8	50	0,36	8,6	4	15°	12°	2	.040030	●		
0,4	0,05	0,3	1,8	50	0,36	8,6	4	15°	12°	2	.040050	●		
0,4	0,1	0,3	1,8	50	0,36	8,6	4	15°	12°	2	.040100	●		
0,5	0,03	0,35	2,25	50	0,45	8,9	4	15°	11,5°	2	.050030	●		
0,5	0,05	0,35	2,25	50	0,45	8,9	4	15°	11,5°	2	.050050	●		
0,5	0,1	0,35	2,25	50	0,45	8,9	4	15°	11,5°	2	.050100	●		
1	0,03	0,8	4,5	50	0,95	10,2	4	15°	8,5°	2	.100030	●		
1	0,05	0,8	4,5	50	0,95	10,2	4	15°	8,5°	2	.100050	●		
1	0,1	0,8	4,5	50	0,95	10,2	4	15°	9°	2	.100100	●		
1	0,2	0,8	4,5	50	0,95	10,2	4	15°	9°	2	.100200	●		
1,5	0,1	1,1	6,75	50	1,45	11,5	4	15°	6,5°	2	.150100	●		
1,5	0,2	1,1	6,75	50	1,45	11,5	4	15°	6,5°	2	.150200	●		
1,5	0,3	1,1	6,75	50	1,45	11,5	4	15°	6,5°	2	.150300	●		
2	0,1	1,3	9	50	1,95	12,8	4	15°	5°	2	.200100	●		
2	0,2	1,3	9	50	1,95	12,8	4	15°	5°	2	.200200	●		
2	0,3	1,3	9	50	1,95	12,8	4	15°	5°	2	.200300	●		



CBN-Micro- und Mini-Torusfräser – kurze Ausführung
CBN micro and mini torus end mills – short design

H



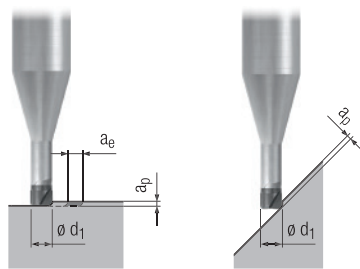
Gültig für · Valid for
2638 2639 2640

	$d_1 = 0,4 \text{ mm}$				$d_1 = 0,5 \text{ mm}$						MMS MQL	
	a_p [mm]	a_e [mm]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]				
Gusswerkstoffe · Cast materials												
K	1.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.1	$0,012 \times d_1$	$0,125 \times d_1$	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	$0,012 \times d_1$	$0,125 \times d_1$	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nichteisenwerkstoffe · Non-ferrous materials												
Kupfer-Legierungen · Copper alloys												
N	2.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.3	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.4	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.5	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.6	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.7	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.8	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Harte Werkstoffe · Hard materials												
H	1.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.3	$0,015 \times d_1$	$0,175 \times d_1$	50000	600	50000	750	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4	$0,012 \times d_1$	$0,125 \times d_1$	50000	500	50000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.5	$0,010 \times d_1$	$0,100 \times d_1$	50000	350	50000	450	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



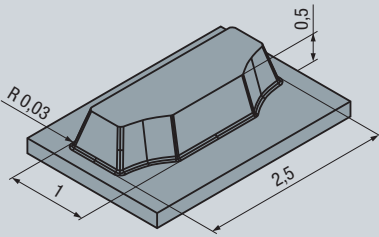
CBN-Micro- und Mini-Torusfräser – kurze Ausführung
CBN micro and mini torus end mills – short design

H



Gültig für · Valid for
2638 2639 2640

	$d_1 = 1,0 \text{ mm}$				$d_1 = 1,5 \text{ mm}$				$d_1 = 2,0 \text{ mm}$						MMS MQL		
	a_p [mm]	a_e [mm]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]	n [min ⁻¹]	V_f [mm/min]					
Gusswerkstoffe · Cast materials																	
K	1.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.1	$0,012 \times d_1$	$0,125 \times d_1$	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	3.2	$0,012 \times d_1$	$0,125 \times d_1$	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nichteisenwerkstoffe · Non-ferrous materials																	
Kupfer-Legierungen · Copper alloys																	
N	2.1	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.2	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.3	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.4	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.5	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.6	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.7	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2.8	$0,015 \times d_1$	$0,175 \times d_1$	50000	1500	50000	2200	50000	3000	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Harte Werkstoffe · Hard materials																	
H	1.1	$0,015 \times d_1$	$0,175 \times d_1$	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.2	$0,015 \times d_1$	$0,175 \times d_1$	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.3	$0,015 \times d_1$	$0,175 \times d_1$	45000	1300	30000	1300	23000	1400	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.4	$0,012 \times d_1$	$0,125 \times d_1$	45000	1100	30000	1100	23000	1200	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	1.5	$0,010 \times d_1$	$0,100 \times d_1$	32000	800	21000	550	16000	600	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



LED-Form

Bearbeitung: Schichten 60 LED Pins
 Material: H **1.3**
 Elmax Superclean 56 HRC
 (rostbeständiger PM-Stahl)
 Werkzeug: CBN-Micro-Torusfräser
 Artikel-Nr.: 2639.040030
 Schneidendm. d_1 : 0,4 mm
 Eckenradius r: 0,03 mm
 Schneidenlänge l_2 : 0,3 mm
 Freie Halslänge l_3 : 1,2 mm
 Zähnezahl: 2

Maschine: Mikron HSM 400LP, HSK-E40
 max. n = 42000 min⁻¹
 Werkzeugspannung: PGR10
 Schmierung: Öl
 CAM-System: OPEN MIND *hyperMILL*®
 Zustellung: 3D steps 0,003 mm
 Drehzahl n: 42000 min⁻¹
 Vorschubgeschwindigkeit v_f : 400 mm/min
 Erreichte Oberflächengüte R_a : 0,042 μ m

Bearbeitungszeit: \approx 400 Minuten

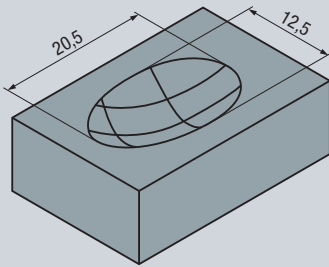
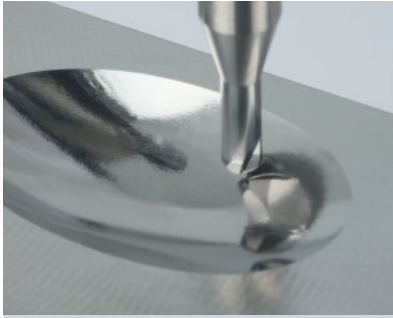
LED mold

Machining: Finishing of 60 LED pins
 Material: H **1.3**
 Elmax Superclean 56 HRC
 (stainless PM steel)
 Tool: CBN Micro torus end mill
 Article no.: 2639.040030
 Cutting dia. d_1 : 0.4 mm
 Corner radius r: 0.03 mm
 Cutting length l_2 : 0.3 mm
 Neck length l_3 : 1.2 mm
 Flutes: 2

Machine: Mikron HSM 400LP, HSK-E40
 max. n = 42000 rpm
 Tool clamping: PGR10
 Lubrication: Oil
 CAM-system: OPEN MIND *hyperMILL*®
 Steps: 3D steps 0.003 mm
 Speed n: 42000 rpm
 Feed speed v_f : 400 mm/min
 Surface quality achieved R_a : 0.042 μ m

Machining time: \approx 400 Minutes





Formeinsatz Linse

Material: H **1.3**
1.2379, 59-60 HRC
Maschine: Hermle C40U, HSK-A63
max. n = 28000 min⁻¹
Werkzeugspannung: PGR
Schmierung: Luft extern
CAM-System: OPEN MIND hyperMILL®
Konturgröße: 20,5 mm x 12,5 mm

Mold insert lens

Material: H **1.3**
1.2379, 59-60 HRC
Machine: Hermle C40U, HSK-A63
max. n = 28000 rpm
Tool clamping: PGR
Lubrication: Air external
CAM system: OPEN MIND hyperMILL®
Size of contour: 20.5 mm x 12.5 mm

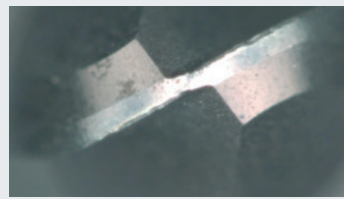
Vergleich von Hartmetall-Kugelfräser zu CBN-Micro-Kugelfräser im Bezug auf Oberflächenqualität und Werkzeugverschleiß nach 5 gefrästen Bauteilen

Comparison of solid carbide ball nose end mill and CBN micro ball nose end mill with regard to surface quality and tool wear after 5 machined components

Strategie: 3D Äquidistantes Schichten
Schneidendrm. d₁: 1,5 mm
Zustellungen: a_p / a_e = 0,01 mm
Schnittgeschwindigkeit v_c: 130 m/min
Drehzahl n: 27600 min⁻¹
Vorschub pro Zahn f_z: 0,013 mm
Vorschubgeschwindigkeit v_f: 700 mm/min

Stategy: 3D equidistant finishing
Cutting dia. d₁: 1.5 mm
Steps: a_p / a_e = 0.01 mm
Cutting speed v_c: 130 m/min
Speed n: 27600 rpm
Feed per tooth f_z: 0.013 mm
Feed speed v_f: 700 mm/min

Hartmetall-Kugelfräser (Wettbewerbsprodukt)
Solid carbide ball nose end mill (competitor product)



Fazit: Werkzeugverschleiß wirkt sich negativ auf die Oberflächenqualität aus
Conclusion: Tool wear has negative effect on surface quality

CBN-Micro-Kugelfräser (Art.-Nr. 2619.150)
CBN micro ball nose end mill (art. no. 2619.150)



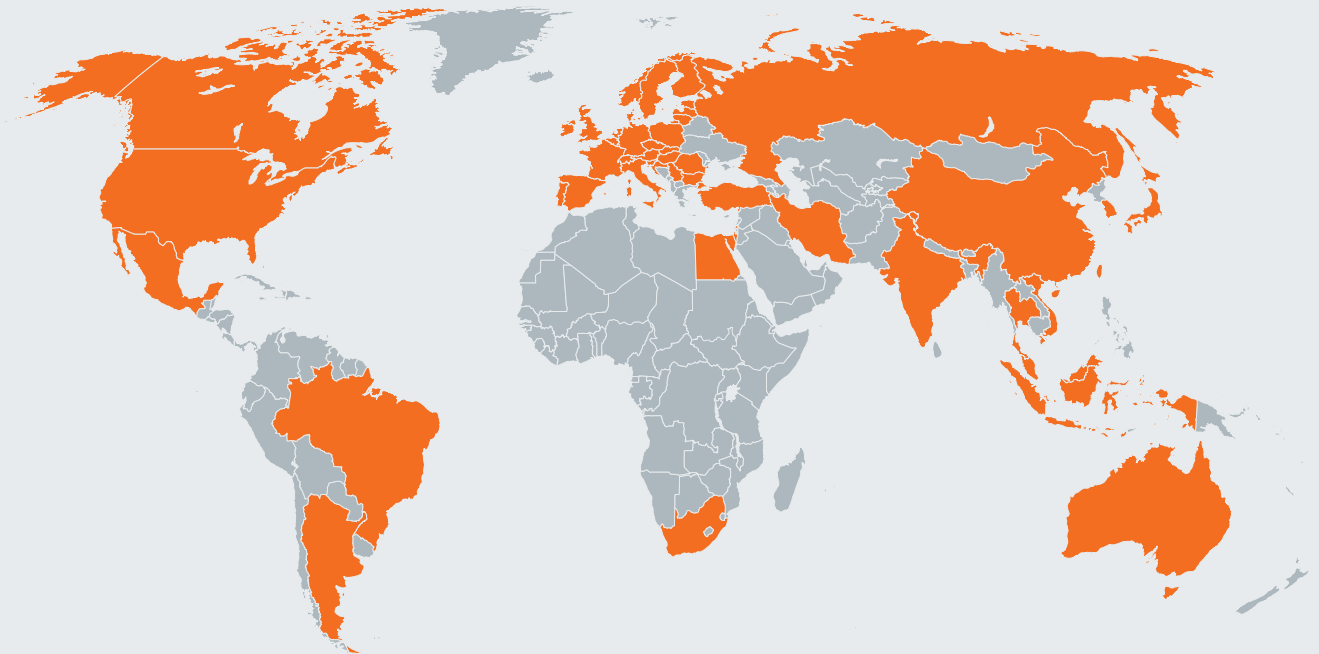
Fazit: Konstante Oberflächenqualität, kaum Werkzeugverschleiß
Conclusion: Consistent surface quality, almost no tool wear

Einsatzgebiete – Material
Applications – material

Material-Beispiele
Material examples

Material-Nummern
Material numbers

	Gusswerkstoffe	Cast materials			
K	1.1 Gusseisen mit Lamellengrafit (GJL)	Cast iron with lamellar graphite (GJL)	100-250 N/mm ²	EN-GJL-200 (GG20)	EN-JL-1030
	1.2 Gusseisen mit Kugelgrafit (GJS)	Cast iron with nodular graphite (GJS)	250-450 N/mm ²	EN-GJL-300 (GG30)	EN-JL-1050
	2.1 Gusseisen mit Kugelgrafit (GJS)	Cast iron with nodular graphite (GJS)	350-500 N/mm ²	EN-GJS-400-15 (GGG40)	EN-JS-1030
	2.2 Gusseisen mit Kugelgrafit (GJS)	Cast iron with nodular graphite (GJS)	500-900 N/mm ²	EN-GJS-700-2 (GGG70)	EN-JS-1070
	3.1 Gusseisen mit Vermiculargrafit (GJV)	Cast iron with vermicular graphite (GJV)	300-400 N/mm ²	GJV 300	
	3.2 Gusseisen mit Vermiculargrafit (GJV)	Cast iron with vermicular graphite (GJV)	400-500 N/mm ²	GJV 450	
4.1 Temperguss (GTMW, GTMB)	Malleable cast iron (GTMW, GTMB)	250-500 N/mm ²	EN-GJMW-350-4 (GTW-35)	EN-JM-1010	
4.2 Temperguss (GTMW, GTMB)	Malleable cast iron (GTMW, GTMB)	500-800 N/mm ²	EN-GJMB-450-6 (GTS-45)	EN-JM-1140	
N	Nichteisenwerkstoffe	Non-ferrous materials			
	Kupfer-Legierungen	Copper alloys			
	2.1 Reinkupfer, niedriglegiertes Kupfer	Pure copper, low-alloyed copper	≤ 400 N/mm ²	E-Cu 57	EN CW 004 A
	2.2 Kupfer-Zink-Legierungen (Messing, langspanend)	Copper-zinc alloys (brass, long-chipping)	≤ 550 N/mm ²	CuZn37 (Ms63)	EN CW 508 L
	2.3 Kupfer-Zink-Legierungen (Messing, kurzspanend)	Copper-zinc alloys (brass, short-chipping)	≤ 550 N/mm ²	CuZn36Pb3 (Ms58)	EN CW 603 N
	2.4 Kupfer-Aluminium-Legierungen (Alubronze, langspanend)	Copper-aluminium alloys (alu bronze, long-chipping)	≤ 800 N/mm ²	CuAl10Ni5Fe4	EN CW 307 G
	2.5 Kupfer-Zinn-Legierungen (Zinnbronze, langspanend)	Copper-tin alloys (tin bronze, long-chipping)	≤ 700 N/mm ²	CuSn8P	EN CW 459 K
	2.6 Kupfer-Zinn-Legierungen (Zinnbronze, kurzspanend)	Copper-tin alloys (tin bronze, short-chipping)	≤ 400 N/mm ²	CuSn7 ZnPb (Rg7)	2.1090
2.7 Kupfer-Sonderlegierungen	Special copper alloys	≤ 600 N/mm ²	(AMPCO® 8)		
2.8 Kupfer-Sonderlegierungen	Special copper alloys	≤ 1400 N/mm ²	(AMPCO® 45)		
H	Harte Werkstoffe	Hard materials			
	1.1 Hochfeste Stähle, gehärtete Stähle, Hartguss	High strength steels, hardened steels, hard castings	44 - 50 HRC	Weldox 1100	
	1.2 Hochfeste Stähle, gehärtete Stähle, Hartguss	High strength steels, hardened steels, hard castings	50 - 55 HRC	Hardox 550	
	1.3 Hochfeste Stähle, gehärtete Stähle, Hartguss	High strength steels, hardened steels, hard castings	55 - 60 HRC	Armox 600T	
	1.4 Hochfeste Stähle, gehärtete Stähle, Hartguss	High strength steels, hardened steels, hard castings	60 - 63 HRC	Ferro-Titanit	
1.5 Hochfeste Stähle, gehärtete Stähle, Hartguss	High strength steels, hardened steels, hard castings	63 - 66 HRC	HSSE		



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