Science.
Applied to Life.™

3M Precision Grinding & Finishing

3M™ Diamond Dressing Rollers

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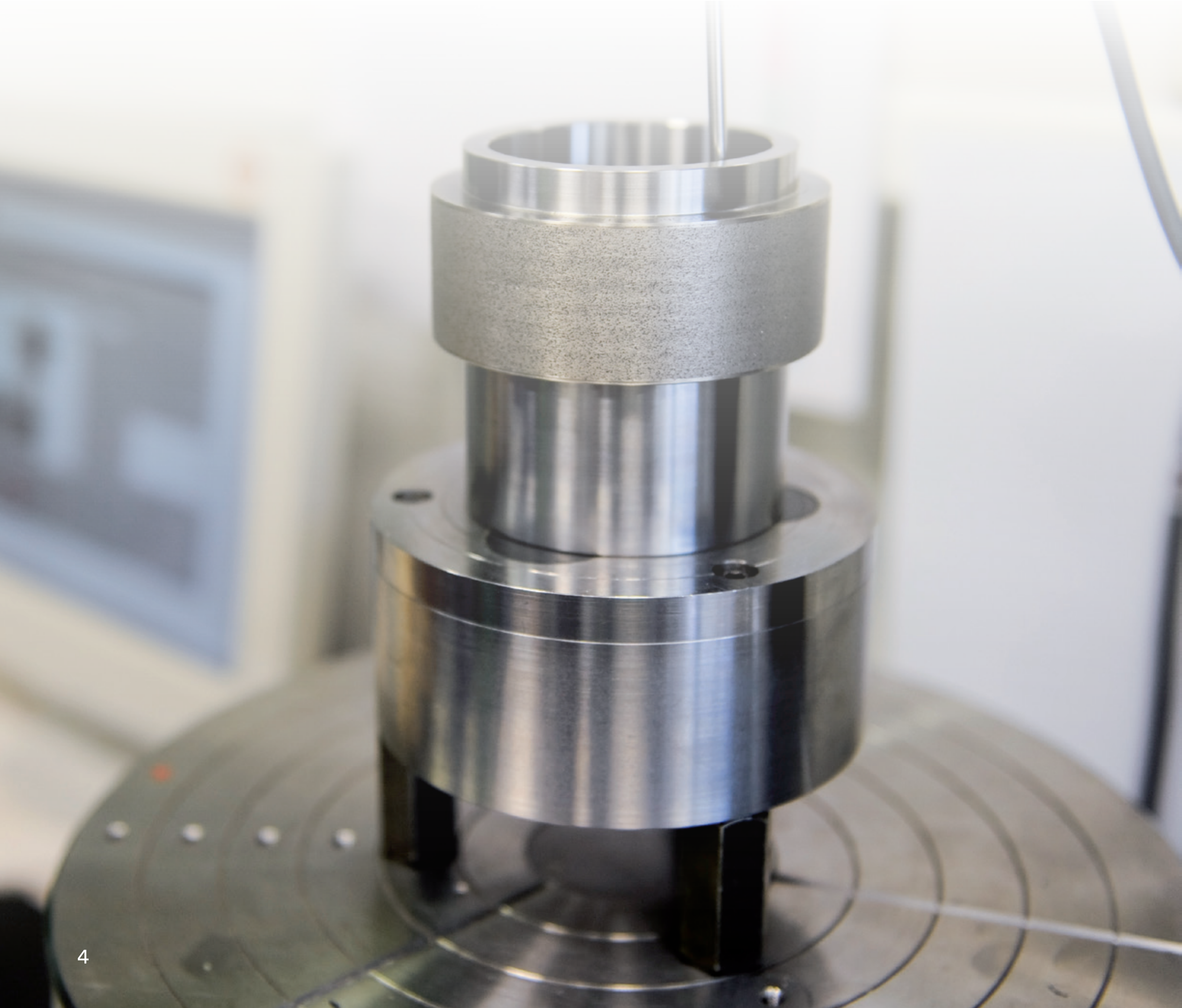
3M™ Diamond Dressing Rollers

For every application

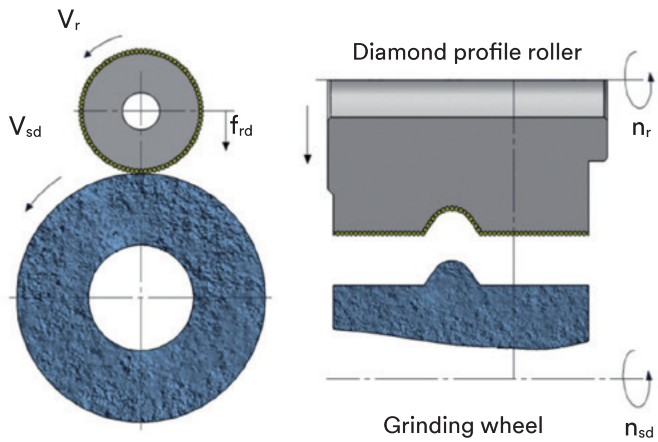
As an integral part of modern precision grinding technology, diamond dressing rollers are primarily used in medium-sized and mass production. On the following pages, we present a wide variety of designs of our diamond dressing tools for use in a large number of application areas.

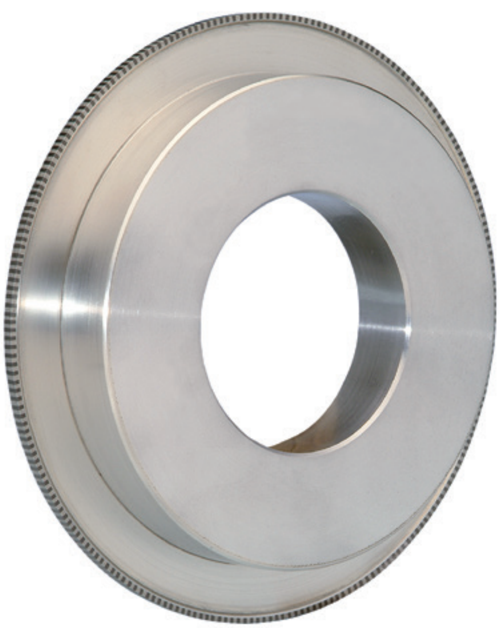
We would be happy to help you with proven recommendations regarding the applications and operating conditions of our diamond profile dressing rollers and our diamond form dressing rollers.



3M™ Diamond Profile Dressing Rollers

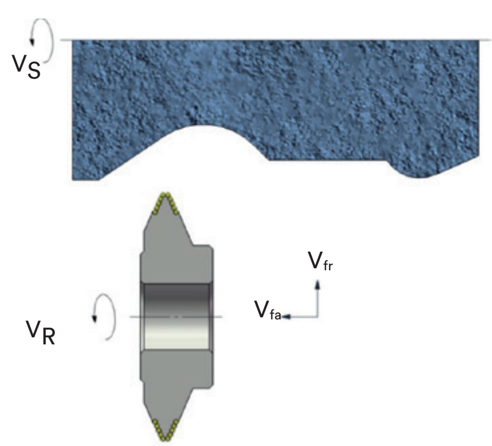
- To shape grinding wheels in the shortest possible time
- Profiling of the grinding wheel in only one operation using the plunge-cut dressing method
- Extreme accuracy, even with highly complex profile contours
- Highest cost-effectiveness





3M™ Diamond Form Dressing Rollers

- Profiling of the grinding wheel along the desired contour by moving the diamond form roller
- Extreme accuracy for simple and highly complex profile contours
- Highest cost-effectiveness



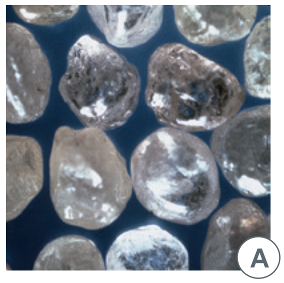
Diamond layer

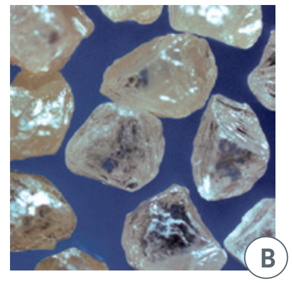
When it's really hard

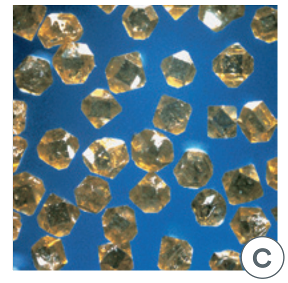
The arrangement and grain density of the diamonds on the coated profile surface or in the bond is what we call the diamond pattern. Profiles exposed to heavy wear, particularly edges, are strengthened. The density of the coating is determined by distance.

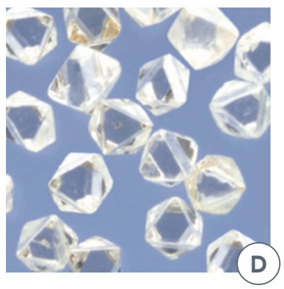
Our form dressing rollers are available with hand-set or randomly distributed diamond layers, and are increasingly being equipped with polycrystalline diamond inserts that can be reground several times.

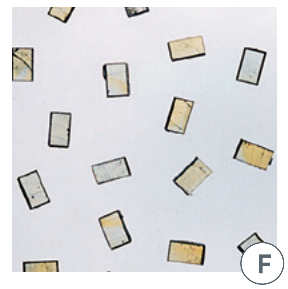
Depending on the customer's requirements, the diamond patterns of our dressing tools are specified after considering the profile geometry, the required workpiece surface quality, the precision requirements, and the operating conditions.





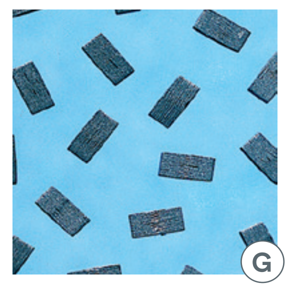






Various types of diamonds

- A Natural diamond grain, rounded
- B Natural diamond grain, sharp
- C Synthetic diamond grain
- D Natural edge reinforcement, octahedron-shaped
- E Natural edge reinforcement, needle-shaped
- F Monocrystalline synthetic edge reinforcement
- G Polycrystalline diamond inserts



Screen grit sizes

FEPA Standard (metric)			US Standard ASTM-E-11 (mesh)		
Size range narrow	Size range wide	Screen mesh size (µm)	Size range narrow	Size range wide	Grains per ct
D1181	D1182	1180 - 1000	16 / 18		< 100
D1001		1000 - 850	18 / 20		~ 200
D851	D852	850 - 710	20 / 25	20/30	~ 300
D711		710 - 600	25 / 30		~ 400
D601	D602	600 - 500	30 / 35	30/40	~ 700
D501		500 - 425	35 / 40		~ 1200
D426	D427	425 - 355	40 / 45	40/50	~ 2000
D356		355 - 300	45 / 50		~ 4000
D301		300 - 250	50 / 60		~ 6000
D251	D252	250 - 212	60 / 70	60/80	~ 8000
D213		212 - 180	70 / 80		~ 17000
D181		180 - 150	80 / 100		~ 25000
D151		150 - 125	100 / 12		~ 50000

The following are the determining factors for the diamond layer:

Diamond grit size

We determine the diamond grit size according to the profile geometry, the smallest convex radius present in the profile in connection with the corresponding enclosed angle, and the required surface quality of the workpiece. The grit size can only be determined based on the required workpiece surface quality for profile geometries that allow edge reinforcements to be inserted for small radii. In general, the grit size should be as large as possible in order to extend the lifetime of the tools. The diamond grit size required is selected from the narrow or wide size range of the FEPA* standard for diamond grit sizes.

* Federation of the European Producers of Abrasives

Diamond content

The diamond content, which is specified using carats as the unit of weight (1 ct = 0.2 g), of tools manufactured using electroplating technology depends on the grit size and is calculated using the area of the surface covered with diamonds and the grain density in ct/cm^2. For tools manufactured using a sintering process, though, the diamond content results from the coating volume and the concentration (ct/cm^3). The number of edge reinforcements and polycrystalline inserts is calculated from the mesh dimensions. Precise knowledge of the diamond content, the grit size, the diamond quality, and the edge reinforcement are especially important when comparing prices.

Diamond quality

We use naturally shaped or rounded natural or synthetic grains in our dressing tools. The base grains consist of block-like, high-strength crystals with an irregular surface that gives them outstanding bonding properties and prevents grain pull-out.

Needle-shaped or octahedron-shaped natural diamonds are used for edge reinforcement, but we also use monocrystalline synthetic diamonds. The latter are also used to manufacture highly wear-resistant and thermally stable form dressing rollers. The diamond quality is specified based on the diamond pattern and the processing conditions while taking the effective roughness the grinding wheel into account.

The following generally applies ...

... the denser the diamond pattern, the sharper the grain, i.e. naturally shaped grains are used for random diamond patterns and rounded grains are used for hand-set diamond patterns.

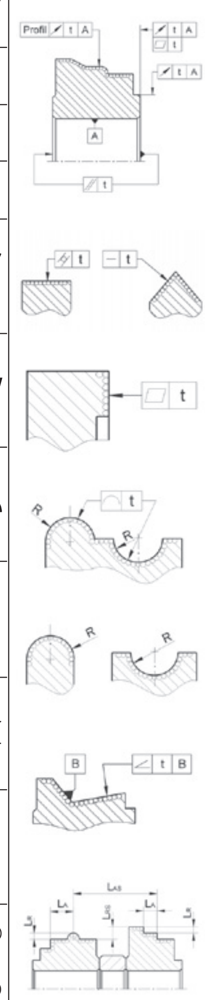
Tolerances

Exact, accurate and precise

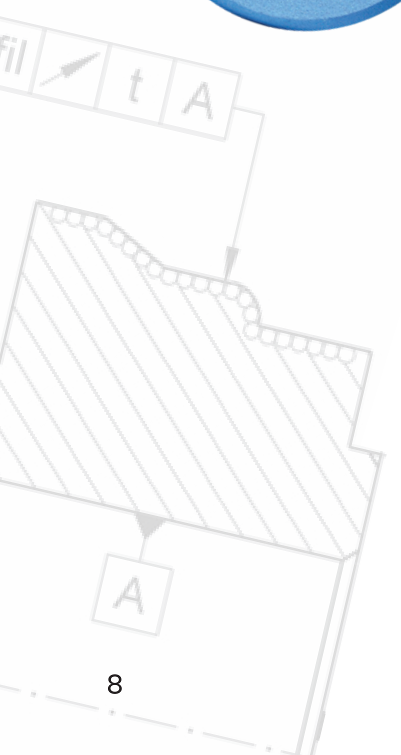
The manufacturing precision of our diamond dressing rollers is generally 2/3 of the workpiece dimensional tolerances and form tolerances (table to the right). It is possible for us to manufacture our dressing tools with very tight tolerances, but the following applies: the lower the tolerance, the higher the price.

Our diamond profile dressing rollers and diamond form dressing rollers are balanced according to DIN ISO 1940 with a quality grade of G1.

Product Code	3M™ 6HGN 3M™ 6JGN	3M™ 6HMI 3M™ 6JMI	3M™ 6HGP 3M™ 6JGP	3M™ 6HMS	Symbol
Type	NZ	IZ	PM	SM	
Designation	Dimension in mm				
Parallelism	0.002	0.002	0.005	0.005	//
Peripheral runout	0.002	0.002	0.005	0.005	↗
Side runout	0.002	0.002	0.005	0.005	↗
Run-out	0.004	0.004	0.01	0.02	↗
Cylindricity	0.004 (0.002)	0.004 (0.002)	0.01	0.02	⌭
Planeness	0.004	0.004	0.01	0.02	▱
Linear shape	0.004 (0.002)	0.01 (0.003)	0.01	0.02	⌒
Radius	± 0.002 (± 0.001)	± 0.004 (± 0.003)	± 0.025	± 0.025	R
Angle	0.004 (0.002)	0.004 (0.002)	0.01	0.01	∠
Length	± 0.002 (± 0.001)	± 0.002 (± 0.001)	± 0.025	± 0.025	L_A 1) L_R 1)
Length with set of rollers	± 0.01 (± 0.003) ± 0.002	± 0.01 (± 0.005) ± 0.01	± 0.025 ± 0.05	± 0.025 ± 0.05	L_{AS} 2) L_{RS} 2)



1) L_A = Axial length ; L_R = Radial length
2) L_{AS} = Axial length with sets of rollers ; L_{RS} = Radial length with sets of rollers



Types

Reverse electroplated

• NZ type (randomly distributed diamonds)
• NS type (hand-set diamonds)
• NM type (hand-set/randomly distributed diamonds)

To electroplate these tool types during the manufacture of the tools using the reverse electroplating method, a metal female mold with the reverse image of the dressing roller is produced first. The diamond grains are placed on surface of the profile (randomly distributed for the NZ type, hand-set for the NS type, hand-set/randomly distributed for the NM type).

On all dressing tools manufactured using the reverse electroplating method, the diamonds lay on the enveloping surface of the profile so that each grain actively participates in the dressing process and enable the longest possible lifetimes. Tools of these types allow even the tightest tolerances to be maintained and are used as a standard for all types of profiles, and especially for very fine profiles.

They are also used when a high effective roughness is desired. The NM type is used increasingly to grind workpieces that tend to burn when grinding certain parts of the profile.

Reverse infiltrated

• IZ type (randomly distributed diamonds)
• IS type (hand-set diamonds)

To manufacture these very robust tools made using the reverse electroplating by infiltration method, a graphite mold with the reverse image of the profile of the dressing roller is produced. The shrinkage inherent in the process needs to be taken into account when making the mold. The diamond grains are placed on the surface of the profile (randomly distributed for the IZ type, hand-set for the IS type).

These types allow tight tolerances to be maintained, but there are some profile-dependent restrictions for the IZ type, although the IZ type has the advantage of shorter manufacturing times. The IS type is recommended for profiles with featuring high, narrow ribs that cannot be electroplated.

Positive electroplated

• PM type (randomly distributed diamonds)

Tools of this type are manufactured using the positive electroplating process. A steel hub bears the profile the dressing roller reduced by an amount equal to the size of the diamond grains. The diamond grit is then placed on the surface of the hub profile and electroplated with nickel. The diamond grains are on single plane on the hub.

Due to variations in size of the diamond grains, the active surface of the dressing roller is rough and uneven. Tools of this type are therefore extremely aggressive and have the highest effective roughness. Dressing rollers manufactured using the positive electroplating process are not used in applications with high precision requirements and feature lower manufacturing costs and high efficiency since the hub can be recoated several times.

Sintered

• SM type (diamond interspersed)

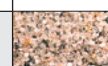
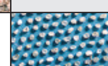
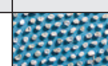
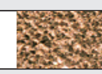
To manufacture these tools using the sintering process, a prefabricated dressing roller body is mounted in a press mold made of hot work tool steel. The diamond coating, a mixture of diamond grains and bonder, is poured into the mold, compacted at high pressure, and sintered at high temperature. After cooling, the tool is carefully finished until the final shape is reached and the diamond grains are exposed.

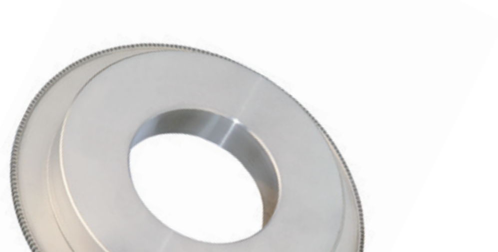
In contrast to all other types that have a coating thickness corresponding to the grain size, with this type a coating thickness of several times the diamond grain size is possible. In general, thickness of 2, 3, or 5 mm are used in applications. Dressing rollers of this design are used for simple profiles without high precision requirements and are applied so that the original shape is retained for a long time. They are sharpened occasionally to achieve longer tool lifetime. In the form of dressing rollers or dressing cups, they are suitable for dressing ceramic-bonded CBN grinding wheels.

Selection criteria

The right tool for every application

As an orientation aid, we have collected the essential features and characteristics of our most important types of tools:

Product Code		3M™ 6HGN 3M™ 6JGN			3M™ 6HMI 3M™ 6JMI		3M™ 6HGP 3M™ 6JGP	3M™ 6HMS
Type		NZ	NS	NM	IS	IZ	PM	SM
Manufacturing process	Reverse method	◆	◆	◆	◆	◆		
	Positive method						◆	◆
Bond	Electroplated nickel	◆	◆	◆			◆	
	Infiltrated tungsten				◆	◆		
	Sintered bronze							◆
Diamond layer	Randomly distributed							
	Hand-set							
	Hand-set/randomly distributed							
	Saturated							
	Edge reinforcement	◆	◆	◆	◆	◆		
	Polycrystalline shape		◆		◆		◆	
	Grain size ≥ D151	◆		◆		◆	◆	◆
	Grain size ≥ D602		◆	◆	◆			
Highest execution accuracies		◆		◆				
Finest profiles		◆		◆				
Profile with high, narrow ribs					◆			
Highly robust					◆		◆	◆
High effective roughness			◆	◆	◆		◆	
Partial avoidance of grinding burn				◆				
Shortest delivery times						◆	◆	



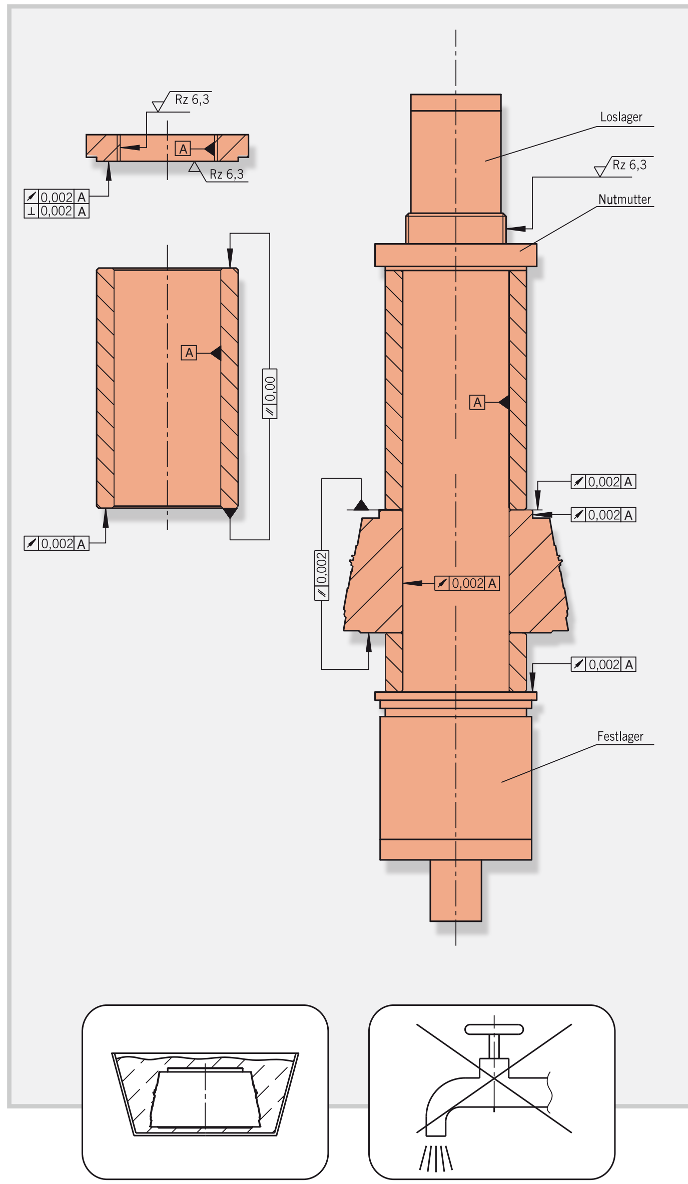
Preparations for use

The installation

The proper installation of a diamond dressing roller has a major influence on the dressing/grinding results and the lifetime of the dressing tool. We recommend you install the tool according to the following rules:

- Check for cleanliness and clean all components, if necessary.
- Check to ensure the surfaces of the arbor, the spacer ring, and the clamping nut are in perfect condition. Pay special attention to any friction deposits or machining marks present.
- Check the parts to be mounted to ensure the manufacturing tolerances are maintained. The actual size of the dressing roller hole can be found in the test report. The determination and maintenance of the minimum tolerance clearance is especially important in this regard.
- Test the concentricity and axial run-out of the grinding wheel arbor. The maximum permissible run-out error is 0.002 mm.
- Clean the parts to be mounted with a towel soaked in acid-free oil so that a thin film of oil remains on the parts. Avoid leaving fingerprints on the connection points.
- Push the parts carefully into the specified order, and, only by moving them into the axial position, onto the arbor.

Installation is much easier if the dressing roller is warmed up in an oil or water bath. The maximum permissible temperature is 40°C. Do not warm the dressing roller under running water. After installation is completed, conduct a test of the radial and axial run-out of the dressing roller on the arbor and again on the corresponding test collar after installation in the machine. If the values of radial and axial run-out deviation are greater than 0.005 mm, then the dressing roller must be reinstalled, taking the points stated into account.



Operating conditions

We know how to do it

The ability to influence process-relevant factors such as the operating conditions, configuration of the axes, speed ratio, direction of rotation, infeed, and rollout when profiling with diamond profile dressing rollers offers numerous opportunities for optimization of the results.

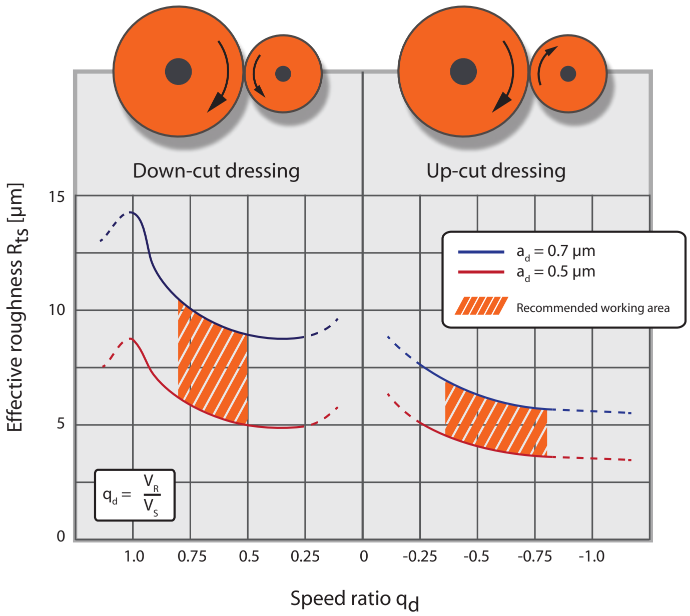
When profiling with form dressing rollers, it is also possible to specifically influence the topography on the grinding wheel and optimize the results by matching the individual factors such as the working conditions, infeed per overflow, speed ratio, direction of rotation, feed rate, etc.

Influencing factors that can be coordinated:

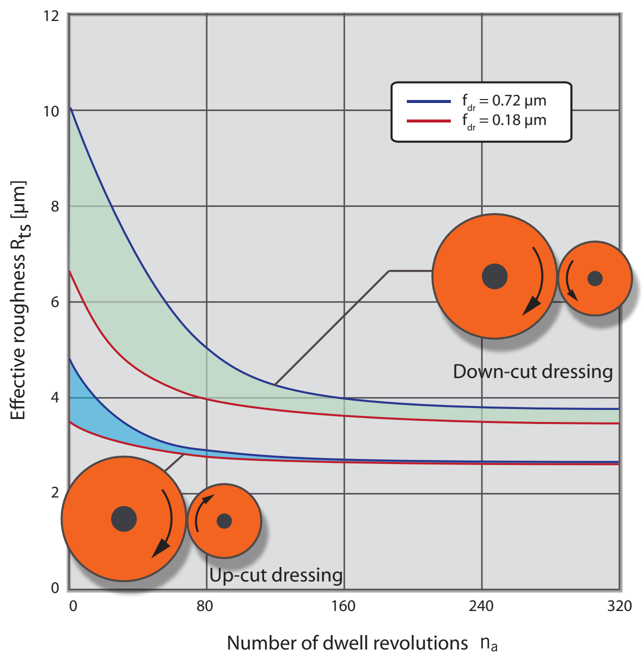
Direction of rotation

Down-cut and up-cut dressing refers to the relative direction of rotation of the diamond dressing roller with respect to the grinding wheel. They have correspondingly different effective roughnesses (Diagram 1). Since down-cut dressing is associated with high effective roughnesses, it is used for high performance profiling of rough grinding wheels and fine grinding of critical profiles that have a tendency to burn when grinding. By changing the speed ratio, it is possible to have a greater influence on the effective roughness than with up-cut dressing. Up-cut dressing, which is associated with a lower effective roughness, is used for fine grinding wheels used to grind non-critical profiles that do not tend to burn during grinding.

3M™ Diamond Profile and Form Dressing Rollers
Diagram 1



3M™ Diamond Profile Dressing Rollers
Diagram 2



Speed ratio (q_d)

The greatest influence on the effective roughness is obtained by changing the speed ratio q_d, which is the quotient of the circumferential speed of the dressing roller V_R to the circumferential speed of the grinding wheel V_S (Diagram 1: Down-cut and up-cut dressing at different feed increments). Speed ratios of 1 or almost 1 are not permitted since they indicate that the diamond dressing roller is either dwelling on the grinding wheel or that the dressing roller is prematurely worn or damaged.

Axial feed rate (v)

Another working parameter required when using diamond form dressing rollers is a feed movement with velocities in the axial or tangential direction. As the feed rate increases (in down-cut dressing more than in up-cut dressing), the effective roughness increases. Since the feed rate depends on the combination of the application and working conditions, we can only specify 100–300 mm/min as a standard value for rough grinding and 30–100 mm/min for finish grinding.

Dwell revolutions (n_a)

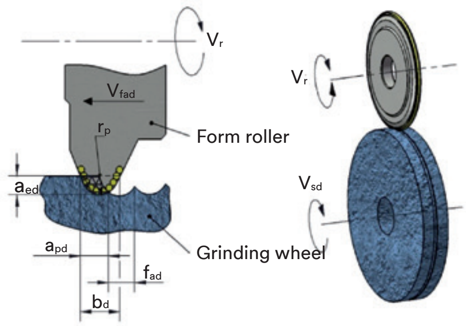
The effective roughness is also influenced by the number of dwell revolutions (n_a). As the number of revolutions increases (for down-cut dressing more than for up-cut dressing), the effective roughness decreases (Diagram 2). At about 150 dwell revolutions for down-cut dressing and 50 dwell revolutions for up-cut dressing, it becomes impossible to minimize the values any further. While the number of dwell revolutions needs to be kept low in cases where there is a tendency of grinding burn, they should be increased when the surface roughness values of the workpiece are high. (All values were determined in fixed systems with specific machine and equipment stiffness values, but are still useful in a general sense.)

Infeed (a_d)

Our parameter for the infeed is the radial feed increment a_d (µm) of the diamond dressing roller per revolution of the grinding wheel. As the infeed increases (for down-cut dressing more than for up-cut dressing), the effective roughness increases (Diagram 1). The recommended feed increments are between 0.25 – 0.5 µm per revolution of the grinding wheel. The total infeed selected should always be as small as necessary to restore the grinding wheel profile (generally < 0.03 mm). When continuous dressing (CD), the tool is fed continuously at a rate of up to 0.2 µm per revolution of the grinding wheel.

When profiling with diamond form dressing rollers, the feed increment depends mainly on the type of form dressing roller, the desired grinding wheel profile, the cutting conditions, and whether you are rough grinding or finishing grinding. Due to the numerous combinations of the application and working conditions, we can only specify 0.1–0.5 mm as a standard value for rough grinding and 0.005–0.05 mm for finishing grinding.

Terms and Formulas



Dressing overlap ratio

$$U_d = \frac{a_{pd}}{f_{ad}}$$

Dressing speed ratio

$$q_d = \pm\frac{v_r}{v_{sd}}$$

with $b_d = \sqrt{8 \cdot r_p \cdot a_{ed}}$

+ Down-cut
- Up-cut

$a_{pd} = \frac{1}{2}(b_d + f_{ad})$ Width of cut

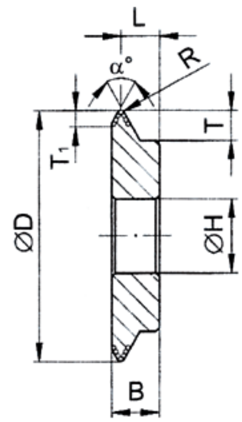
a_{pd}	Width of cut	in mm
a_{ed}	Dressing infeed	in µm
b_d	Effective width of the dressing tool	in mm
f_{ad}	Dressing infeed per revolution	in mm/U
v_{fad}	Axial feed rate	in mm/min
v_r	Dressing roller circumferential speed	in m/s
v_{sd}	Grinding wheel circumferential speed	in m/s
r_p	Profile radius of the form roller	in mm

Form shapes

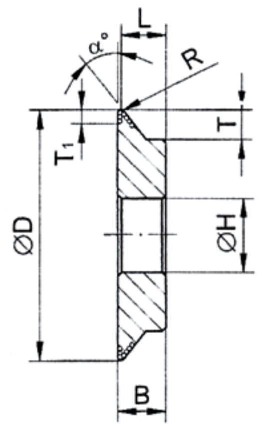
Form dressing rollers

Since the introduction of CNC-controlled dressing processes, a large number of diamond form dressing rollers have entered the market, making it difficult or impossible to get oriented in the market. With our form dressing roller standard, we strive to reduce the number of different types to a reasonable size to enable efficient storage and inexpensive manufacturing of the tools. In this manner, we contribute to the economical optimization of our customers' grinding processes.

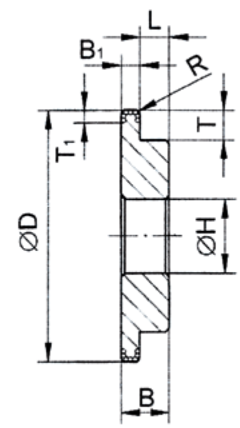
Form shape 01



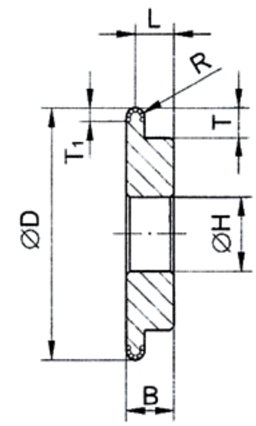
Form shape 02



Form shape 03



Form shape 04



Form roller	D	B	T	L	H
U75B	150	20	15	The actual reference dimension is specified in the test report.	52
	125	15			
	100				40
	75	10			10

Form shape	01 02 03	04	01 02	01 02 03 04	03	01 02 03 04
Type	R		m	T_1	B_1	min. ⌒
NZ	0.3	3	40°	R+1	6	0.003
NS	0.5	3	40°	R+1	6	0.005
IZ	0.3	1	30°	R+1	2	0.01
IS	0.5	1.5	40°	R+1	3	0.01 (0.003)
SM	0.5	1	30°	4	2	0.02

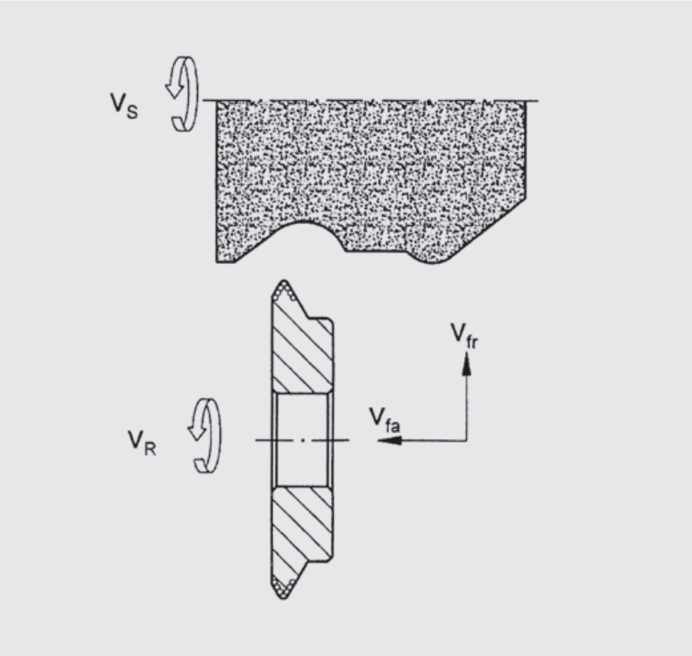
Other form shapes or dimensions available on request

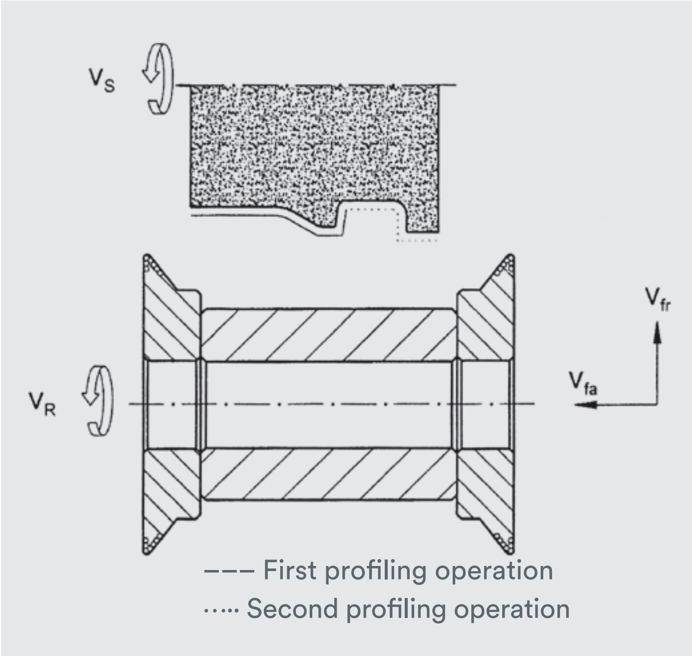
All data in mm.

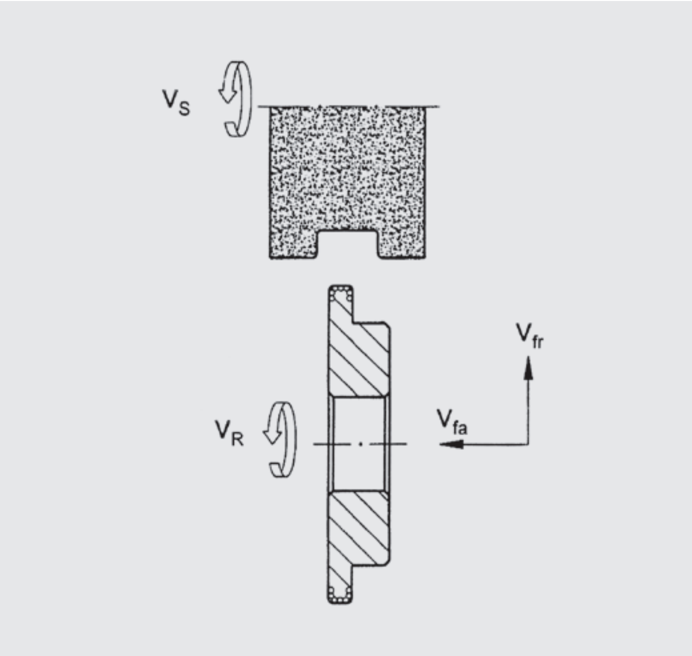
Sample order:	3M	Form shape	D	Type
	U75B	**02**	**100**	**NZ**

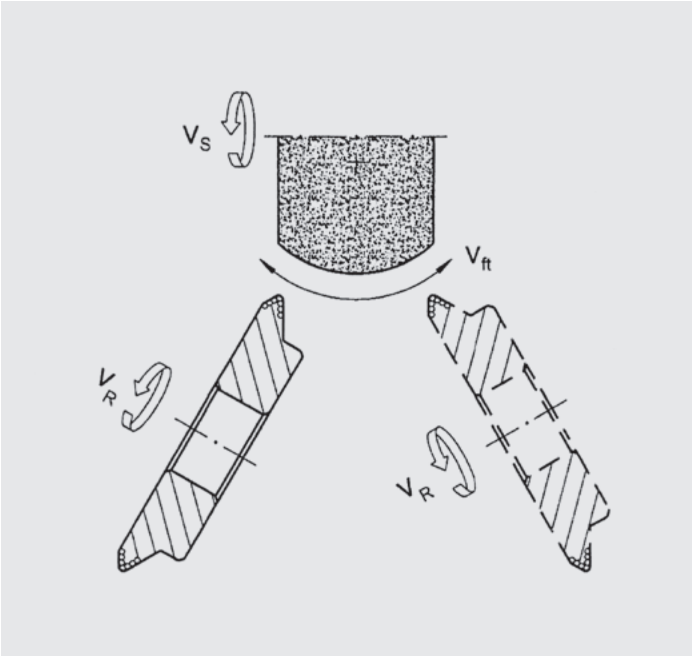
Methods of application

Different types of form dressing rollers are needed depending on desired grinding wheel profile.









Sales and service

We offer more than good products

Requesting an offer

To allow us to create the technically and economically optimal offer, we ask that you provide detailed information on the dressing task and operating conditions of the desired dressing tool on our data sheet. We can also create an offer based on existing tool or workpiece diagrams.

Prices

The prices of our dressing tools are based primarily on the following criteria:

- Precision requirements
- Design type
- Diamond quality
- Diamond content
- Amount of engineering and manufacturing work required
- Total scope of delivery

First order

You only need the offer number to place the order. If there should be any changes, then a current drawing will also be needed.

Repeat/follow-up order

You only need the article number to place an order.

Scope of delivery

- Test report in the form of a detailed manufacturing drawing
- Test coupon for profiles manufactured using the reverse plating method
- Secure packaging in a wooden box placed inside a larger box
- Free advice and consulting

Lifetime

The life expectancy of our dressing rollers can vary greatly depending on the type selected, the application, and the working conditions so that we can only provide figures based on experience:

- Grinding of workpieces with a normal level of complexity in terms of the profiles and tolerances as well as average mean surface qualities: 50,000 – 200,000 dressing operations.
- Grinding of workpieces with fine profiles, low tolerances, and high surface qualities: 5,000 – 50,000 dressing operations.

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