

Grinding tool and method for producing a grinding tool

The invention relates to a grinding tool and to a method for producing a grinding tool.

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A roughing grinding wheel is known from EP 1 543 923 A1. The roughing grinding wheel has two layers of bonded abrasive particles, the layers being reinforced by external reinforcements and internal reinforcements. An annular separating layer is arranged between the inner reinforcements. The separating layer is formed by intermediate layers that rest against one another and are composed of paper or plastic film, for example. The separating layer reduces the amplitude of the vibration during grinding without making the structure of the abrasive grit bound by means of binder softer and without increasing abrasion.

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15 It is the underlying object of the invention to provide a grinding tool which is simple to produce and can be used in a flexible manner and which has high vibration and noise damping combined with high cutting performance and a long life.

This object is achieved by means of a grinding tool having the features of claim 1.

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By virtue of the fact that the at least one fiber ply is arranged in the binder in a partially movable manner, free relative movement is achieved within the at least one fiber ply during grinding, with the result that the main body achieves high vibration and noise damping. To achieve the free relative movement within the at least one fiber ply, the amount of binder used in the production of the main body is, on the one hand, sufficiently large to ensure that the main body has adequate stability and, on the other hand, sufficiently small to ensure that the at least one fiber ply is not bonded continuously and/or over its entire surface to the binder. The at least one fiber ply is embedded in the binder in such a way that a first region of the at least one fiber ply is firmly connected to the binder and a second region of the at least one fiber ply is movable relative to the binder and the first region. The at least one fiber ply preferably has at least one yarn. The at least one yarn is arranged in the

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binder in a partially movable manner. The at least one yarn preferably has a first yarn portion, which is arranged in such a way as to be immovable relative to the binder, and at least one second yarn portion, which is arranged in a movable manner relative to the binder. The second yarn portion is, in particular, arranged in a movable manner relative to the first yarn portion. The binder is preferably a resin and/or an adhesive. The binder is preferably a thermoset, in particular phenolic resin or epoxy resin.

The main body and thus the grinding tool can be produced in any desired shape, providing great flexibility in the use of the grinding tool. The vibration- and noise-damping design of the main body does not have a disadvantageous effect on the abrasive layer. The abrasive layer is arranged directly and/or indirectly on the main body, which ensures high stability and a long life by means of the at least one fiber ply. The grinding tool is furthermore simple to produce.

The abrasive layer is designed to match the intended use of the grinding tool. The abrasive layer preferably comprises an abrasive particle layer which is applied electrostatically to the main body. The abrasive particles of the abrasive particle layer are, in particular, secured by means of an adhesive agent on a surface of the main body. In particular, the abrasive particles are at least partially aligned with the main body and/or with respect to one another. The abrasive particles have a geometrically determined and/or a geometrically indeterminate shape. The abrasive particles comprise at least one material selected from the group comprising ceramics, corundum, in particular zirconia corundum, diamond, cubic crystalline boron nitride (CBN), silicon carbide, and tungsten carbide. The abrasive particles can be applied in a single layer or in multiple layers. In the case where a plurality of abrasive particle layers are formed, an adhesive agent is applied to the respective abrasive particle layer situated underneath, and the subsequent abrasive particle layer is applied. The abrasive particle layer is secured on the main body or a supporting layer, which is connected to the main body. The abrasive layer comprises, in particular, a base binding,

abrasive particles, and a top binding. The abrasive particles can be introduced at different base binding levels or applied to the main body.

5 The abrasive layer comprises, in particular, an abrasive fleece. The abrasive fleece is secured by means of an adhesive agent, for example, on a surface of the main body. The abrasive layer furthermore comprises an abrasive on a backing. The abrasive on a backing comprises, in particular, a supporting layer on which abrasive particles are secured. The abrasive on a backing is designed as abrasive flaps, for example. The abrasive particles used, in particular diamond abrasive particles, can be
10 used on a metal backing.

The main body preferably has a hub or a shaft for clamping and rotary driving of the grinding tool. The grinding tool is, in particular, a grinding wheel.

15 A grinding tool as claimed in claim 2 ensures high vibration and noise damping. By virtue of the fact that the yarns of the respective fiber ply are arranged in a partially movable manner relative to one another and to the binder, a movement of the yarns relative to one another and thus a relative movement within the respective fiber ply are achieved. The main body preferably has a plurality of fiber plies, the respective
20 yarns of which are embedded in the binder in a partially movable manner relative to one another.

A grinding tool as claimed in claim 3 ensures high vibration and noise damping. The fiber plies are preferably embedded one above the other in the binder. By virtue
25 of the fact that the fiber plies are movable relative to one another in some region or regions, a relative movement within the respective fiber ply, on the one hand, and a relative movement between the fiber plies, on the other hand, are achieved. By virtue of the multi-ply construction, the main body furthermore has a high stability or strength and ensures a long life of the grinding tool. The fiber plies comprise at least
30 one first region, which is connected firmly to the binder, and at least one second region, which is movable relative to the binder and to the at least one first region.

A grinding tool as claimed in claim 4 ensures high vibration and noise damping. In particular, the fiber plies are arranged one above the other. By virtue of the fact that the yarns are arranged in a partially movable manner relative to one another and to the binder, a relative movement between the fiber plies and/or a relative movement within the respective fiber ply are/is achieved.

A grinding tool as claimed in claim 5 ensures high vibration and noise damping and a long life. By virtue of the fact that the at least one fiber ply comprises at least one woven fabric and/or at least one non-crimp fabric, a vibration- and noise-damping relative movement is achieved in a simple manner within the main body. At the same time, the main body has a high stability and accordingly makes possible a long life. The at least one woven fabric and/or the at least one non-crimp fabric comprises at least one yarn, in particular a plurality of yarns. In particular, the at least one woven fabric comprises warp yarns and weft yarns. The at least one yarn comprises a first yarn portion, which is immovable relative to the binder, and at least one second yarn portion, which is movable relative to the binder and relative to the first yarn portion. For example, the at least one woven fabric has a twill weave. The twill weave fabric allows simple movements of the warp yarns and/or of the weft yarns within the woven fabric and thus relative movement in order to achieve high vibration and noise damping. The at least one woven fabric and/or the at least one non-crimp fabric are/is preferably produced from glass fibers, carbon fibers, cotton and/or polyester.

A grinding tool as claimed in claim 6 ensures high vibration and noise damping in combination with a long life. The more fiber plies the main body comprises, the higher the degree of relative movement that can be achieved within the main body is. Furthermore, the stability of the main body increases with the number of fiber plies, thereby ensuring a long life. Conversely, the outlay on production increases with the number of fiber plies, and therefore there is an optimum range for the number of fiber plies.

A grinding tool as claimed in claim 7 ensures high vibration and noise damping in combination with a long life. The following applies to the ratio M : $M = m_B/m_F$, where m_B denotes the mass of the binder, and m_F denotes the mass of the at least one fiber ply. On the one hand, the ratio M ensures that the main body has sufficient stability and, in particular, is not delaminated or does not fold over in an unwanted manner during grinding. On the other hand, the ratio M ensures that the at least one fiber ply is not connected fully or over the full area with the binder and that there is no continuous bond with the binder, thus ensuring sufficient relative movement within the main body. The degree of relative movement within the main body is all the greater, the smaller the ratio M . Conversely, the degree of stability is all the greater, the higher the ratio M .

A grinding tool as claimed in claim 8 ensures high vibration and noise damping. The damping particles are incorporated into the main body as a damping additive during production. On the one hand, the damping particles themselves have vibration- and noise-damping properties. On the other hand, the damping particles prevent the at least one fiber ply from being connected fully or over the full area to the binder.

A grinding tool as claimed in claim 9 ensures high vibration and noise damping in combination with a long life. The binder ensures that the at least one fiber ply is reinforced in some region or regions, and the binder itself preferably has damping properties. The binder is a mixture of phenolic resin and natural rubber, for example.

A grinding tool as claimed in claim 10 can be used in a flexible way and ensures high vibration and noise damping in combination with high cutting performance and a long life. The main body is of curved design in at least some section or sections of a working region. In the working region, the abrasive layer is arranged on the main body. The abrasive layer is of curved design in at least some section or sections of

the working region. This enables the grinding tool to be used in a flexible way, e.g. for fillet weld machining and/or for edge machining. The main body and/or the abrasive layer is of curved design, particularly in a radial direction and/or in a circumferential direction relative to an axis of rotation of the grinding tool. The curved design is concave and/or convex. The abrasive layer preferably comprises an abrasive particle layer, which is secured directly on a surface of the main body by means of an adhesive agent. By virtue of the curved design of the main body, forces that arise during grinding can be transferred efficiently to the main body and damped there, with the result that the grinding tool exhibits high vibration and noise damping. By virtue of the fact that the curved main body allows a curved design of the abrasive layer, the cutting performance in different applications is high.

A grinding tool as claimed in claim 11 can be used in a flexible way and ensures high vibration and noise damping in combination with high cutting performance and a long life. The supporting layer serves as an intermediate layer between the main body and the abrasive layer and has advantageous properties, depending on the desired use. The supporting layer is preferably connected monolithically to the main body. In particular, the supporting layer does not form any undercuts with the main body. Abrasive particles are preferably applied immediately or directly to the supporting layer to form the abrasive layer. The abrasive particles are secured by means of an adhesive agent on a surface of the supporting layer, for example. The abrasive particles are secured by electrostatic application on the surface of the supporting layer, for example. The supporting layer is preferably formed from a metallic material.

A grinding tool as claimed in claim 12 ensures flexible usage capability in combination with high cutting performance. The three-dimensional shape of the abrasive layer is dependent on the desired use, and therefore high cutting performance and a long life are achieved for the desired use. The abrasive layer is curved, for example, and/or is aligned in several planes relative to one another, e.g. in planes that extend obliquely relative to one another. The abrasive layer is preferably of curved design

in two directions extending perpendicularly to one another, e.g. in a radial direction and in a circumferential direction relative to the axis of rotation of the grinding tool. A curved design allows fillet weld machining and/or edge machining, for example. By means of planes extending obliquely to one another, the abrasive layer forms a chamfer which allows roughing or surface machining. The abrasive layer is preferably secured by means of an adhesive agent directly on a surface of the main body or on a surface of a supporting layer connected to the main body. In particular, the abrasive layer is produced by electrostatic application of abrasive particles.

10 It is furthermore the underlying object of the invention to provide a method for simple production of a grinding tool which can be used in a flexible manner and which has high vibration and noise damping combined with high cutting performance and a long life.

15 This object is achieved by means of a method having the features of claim 13. The advantages of the method according to the invention correspond to the advantages of the grinding tool according to the invention that have already been described. In particular, the method can also be refined by means of features of the grinding tool, in particular by means of a feature as claimed in at least one of claims 1 to 12.

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A method as claimed in claim 14 ensures the production of the grinding tool with high vibration and noise damping in combination with a long life. The fiber plies are arranged one above the other and are connected to one another in such a way, by heating and then cooling the binder, that, on the one hand, the main body has sufficient stability and strength and, on the other hand, that a relative movement is achieved within the main body.

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A method as claimed in claim 15 ensures the production of the grinding tool with high vibration and noise damping in combination with a long life. By virtue of the fact that the at least one fiber ply, preferably the plurality of fiber plies, is/are compressed during the heating of the small quantity of binder, the binder is distributed

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sufficiently to ensure that the main body retains a sufficient strength. By virtue of the small quantity of binder, however, no continuous or full-area bond is formed within the respective fiber ply and/or between the fiber plies, thus ensuring that a relative movement is achieved within the main body during grinding. The cooling
5 of the binder preferably also takes place under pressure.

A method as claimed in claim 16 ensures simple production of the grinding tool with high vibration and noise damping in combination with a long life. By virtue of the fact that the at least one fiber ply is provided with the binder on only one side
10 and/or only in some region or regions on two sides, no continuous or full-area bond is formed with the binder during the production of the main body. The respective fiber ply is impregnated with the binder, for example. The impregnated fiber ply has been produced in an upstream production step, for example. During the production of the main body, a plurality of fiber plies provided with binder and optionally at
15 least one fiber ply without binder are preferably arranged one above the other.

A method as claimed in claim 17 ensures simple production of the grinding tool with high vibration and noise damping in combination with a long life. By virtue of the fact that the fiber plies with and without the binder are arranged adjacent to one
20 another, no continuous or full-area bond with the binder is achieved during the production of the main body. The desired relative movement within the main body is thereby made possible. A plurality of first fiber plies and a plurality of second fiber plies are preferably arranged alternately one above the other. The respective second fiber ply is preferably provided with the binder on one side or on two sides. The
25 respective second fiber ply is impregnated with the binder, for example.

A method as claimed in claim 18 ensures simple production of the grinding tool with high vibration and noise damping in combination with a long life. As prepared, the at least one fiber ply does not have any binder. On the one hand, the layer of
30 binder arranged adjacent to the at least one fiber ply gives the main body the required strength. On the other hand, the at least one fiber ply does not form a contin-

uous or full-area bond with the binder, and therefore the desired relative movement is achieved within the main body during grinding. The layer of binder is preferably formed as a binder film. One layer of binder, in particular a binder film, is preferably provided between two fiber plies without binder. One fiber ply without binder
5 and one layer of binder, in particular a binder film, are preferably provided alternately.

A method as claimed in claim 19 ensures the production of the grinding tool with high vibration and noise damping in combination with high cutting performance and
10 a long life. The supporting layer serves as an intermediate layer between the main body and the abrasive layer. The supporting layer is formed according to the desired use. The supporting layer is formed, for example, from a metallic material, a woven supporting fabric and/or paper. In particular, the supporting layer is connected monolithically to the main body. The abrasive layer is secured on the supporting layer or
15 on one surface of the supporting layer. The abrasive layer can be arranged or secured on the supporting layer before and/or after the supporting layer is arranged on the main body.

A method as claimed in claim 20 ensures simple production of the grinding tool
20 with the capacity for flexible use in combination with high cutting performance. The abrasive layer comprises an abrasive particle layer formed by the applied abrasive particles. By means of the electrostatic application of the abrasive particles, the abrasive particle layer is secured directly on the main body or on a supporting layer arranged on the main body. Electrostatic application makes possible a three-
25 dimensional shape of the abrasive layer in a simple way, thus allowing the grinding tool produced to be used flexibly. Furthermore, electrostatic application enables the main body or supporting layer to be re-coated or re-covered. Thus, after consumption of an abrasive layer, the remaining grinding tool can be renewed by electrostatic application of a new abrasive particle layer for repeated use. By electrostatic
30 coating, the abrasive particles are applied directionally, in particular according to the course of the electrostatic field lines. High cutting performance, especially when

using abrasive particles with a geometrically determined shape, is thereby achieved. In particular, the abrasive particles are secured on the main body or the supporting layer by means of an adhesive agent. The formation of the abrasive layer is accomplished, in particular, by multiple electrostatic applications of abrasive particles.

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Further features, advantages and details of the invention will become apparent from the following description of a number of illustrative embodiments. In the drawings:

10 Figure 1 shows a sectional view of a grinding tool according to a first illustrative embodiment with a main body and an abrasive layer arranged thereon,

15 Figure 2 shows an enlarged sectional view of the grinding tool in figure 1 to illustrate a structure of the main body with a binder and with fiber plies embedded in a partially movable manner in the binder,

Figure 3 shows a schematic illustration of the production of the main body according to a first method,

20 Figure 4 shows a schematic illustration of the production of the main body according to a second method,

25 Figure 5 shows a schematic illustration of the production of the main body according to a third method,

Figure 6 shows a schematic illustration of the production of the main body according to a fourth method,

30 Figure 7 shows a schematic illustration of the electrostatic application of abrasive particles to the main body,

Figure 8 shows a schematic sectional illustration of a grinding tool according to a second illustrative embodiment, and

Figure 9 shows a schematic illustration of the production of the main body of the grinding tool in figure 8.

A first illustrative embodiment of the invention is described below with reference to figures 1 to 7. A handheld grinding machine (not illustrated specifically) is used in operation to drive a grinding tool 1 in rotation.

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The grinding tool 1 is of disk-shaped design. The grinding tool 1 comprises a main body 2 and an abrasive layer 3 arranged thereon. In a clamping region 4, the main body 2 has a circular opening 5 to receive a drive shaft of the grinding machine. The opening 5 defines an axis of rotation 6 of the grinding tool 1. As an alternative to the opening 5, the grinding tool 1 can have a shaft.

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The grinding tool 1 comprises a working region 7, which surrounds the clamping region 4 in a ring shape. In the working region 7, the abrasive layer 3 is arranged on the main body 2. The working region 7 is divided into an inner region 8 and an outer region 9. The inner region 8 is of annular design and surrounds the clamping region 4. In the inner region 8, the surface of the main body 2 on which the abrasive layer 3 is arranged is of substantially level design. The outer region 9 is of annular design and surrounds the inner region 8. In the outer region 9, the surface of the main body 2 on which the abrasive layer 3 is arranged is of substantially curved design. In the outer region 9, the main body 2 is curved relative to the axis of rotation 6 along a radial direction R and along a circumferential direction U. By virtue of the curvature of the main body 2, the abrasive layer 3 is formed in a correspondingly curved and three-dimensional way.

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30 The main body 2 comprises a number N of fiber plies, wherein the following applies in general: $1 \leq N \leq 12$, in particular $2 \leq N \leq 10$, and in particular $4 \leq N \leq 8$.

The fiber plies are denoted individually by F_i , where i denotes a running index for the individual fiber plies and depends on the number N . By way of example, the grinding tool 1 illustrated in figure 1 comprises four fiber plies, which are denoted individually by F_1 to F_4 . The fiber plies F_1 to F_4 are illustrated only schematically in figure 1. The fiber plies F_1 to F_4 are designed as woven fabric and/or non-crimp fabric.

The main body 2 comprises a binder B , in which the fiber plies F_1 to F_4 are embedded in such a way that the fiber plies F_1 to F_4 are connected partially firmly to the binder B and are arranged in such a way as to be partially movable relative to the binder B and relative to one another. To achieve this, a mass m_B of the binder B to a mass m_F of the fiber plies F_1 to F_4 is relatively small. For a ratio $M = m_B/m_F$ of the mass m_B of the binder B to the mass m_F of the fiber plies F_1 to F_4 , the following applies: $1/25 \leq M \leq 1/2$, in particular $1/20 \leq M \leq 1/3$, in particular $1/15 \leq M \leq 1/4$, and in particular $1/12 \leq M \leq 1/6$. The binder B is an organic adhesive, in particular phenolic resin, epoxy resin and/or natural rubber.

Figure 2 illustrates the partially movable arrangement of the fiber plies F_1 to F_4 in the binder B . The adjacent fiber plies F_1 and F_2 are illustrated by way of example in figure 2. The fiber plies F_1 to F_4 are designed as woven fabrics, for example, and each have a plurality of weft yarns S and warp yarns K extending transversely thereto. In figure 2, the weft yarns S_1 and the warp yarns K_1 of the first fiber ply F_1 and the weft yarns S_2 and the warp yarns K_2 of the second fiber ply F_2 are illustrated. Owing to the relatively small quantity of binder B , connection-free regions V , in which the fiber plies F_1 to F_4 are not connected by the binder B , are formed in the main body 2. In these connection-free regions V , the fiber plies F_1 to F_4 are movable in themselves and relative to the binder B . The fiber plies F_1 to F_4 embedded in the binder B are thus movable in themselves and/or relative to one another in some regions. In the connection-free regions V , the weft yarns S_1 , S_2 and/or the warp yarns K_1 , K_2 are movable relative to one another, for example. The connection-free re-

gions V allow a relative movement of the fiber plies F_1 to F_4 in some regions within the main body 2.

5 The abrasive layer 3 comprises abrasive particles 10 with a geometrically determined shape, which are secured on the main body 2 by means of an adhesive agent 11. The adhesive agent 11 is a resin, in particular phenolic resin, for example. The abrasive particles 10 are arranged directionally relative to one another and relative to a surface of the main body 2. The abrasive particles 10 form an abrasive particle layer 12. A top binding 13 and a top layer 14 are arranged on the abrasive particle
10 layer 12 in the usual way. The top binding 13 and/or the top layer 14 preferably have/has fillers with a grinding action.

By virtue of the fact that the fiber plies F_1 to F_4 allow a relative movement in themselves and/or relative to one another, forces which arise during grinding are absorbed by the main body 2, thereby ensuring high vibration and noise damping.
15 The main body 2 nevertheless has sufficient stability and strength, and therefore the grinding tool 1 has a long life. The main body 2 can be produced easily and in any geometrical shape, and therefore the grinding tool 1 is flexible in application. The abrasive layer 3 is easy to apply to the main body 2 shaped in the desired manner,
20 and therefore the abrasive layer 3 ensures high cutting performance of the grinding tool 1.

The production of the main body 2 is described below:

25 A first production method is illustrated in figure 3. In the first production method, the fiber plies F_1 to F_4 are prepared without binder. Layers of binder B are arranged between the fiber plies F_1 to F_4 that are arranged one above the other. The layers of binder B are designed as binder films. The fiber plies F_1 to F_4 and the layers of binder B arranged therebetween are then pressed against a main body form G under
30 a pressure p and heated in such a way that the binder B becomes fluid. The binder B

connects the fiber plies F_1 to F_4 in the manner described. The main body 2 is formed by cooling the binder B.

A second production method for the main body 2 is illustrated in figure 4. In the second production method, fiber plies F_1 and F_4 are prepared without binder B, and fiber plies F_2 and F_3 are prepared with binder B. Fiber plies F_2 and F_3 are each impregnated with the binder B on both sides. The fiber plies F_1 to F_4 are arranged one above the other and pressed against the main body form G under a pressure p and heated in such a way that the binder B becomes fluid. The binder B connects the fiber plies F_1 to F_4 in the manner described. The main body 2 is formed after the cooling of the binder B.

A third production method for the main body 2 is illustrated in figure 5. In the third production method, the fiber plies F_1 to F_4 are impregnated on one side with the binder B during preparation. The fiber plies F_1 to F_4 are arranged one above the other and pressed against the main body form G under a pressure p and heated in such a way that the binder B becomes fluid. The binder B connects the fiber plies F_1 to F_4 in the manner described. The main body 2 is formed after cooling 4.

A fourth production method for the main body 2 is illustrated in figure 6. In this production method, the prepared fiber plies F_1 to F_4 are each provided in some region or regions with the binder B on two sides. The fiber plies F_1 to F_4 are impregnated with the binder B in some region or regions. The fiber plies F_1 to F_4 are arranged one above the other, pressed against the main body form G under a pressure p and heated in such a way that the binder B becomes fluid. The binder B connects the fiber plies F_1 to F_4 in the manner described. After cooling, the connected fiber plies F_1 to F_4 form the main body 2.

The production method and the fiber plies F_1 to F_4 prepared can be combined with one another in a desired manner.

The formation of the abrasive layer 3 on the main body 2 and the production of the grinding tool 1 are described below:

By means of an application device 15, the abrasive particles 10 are applied electro-
statically to the main body 2. The application device 15 comprises a handling de-
vice 16 for handling and positioning the main body 2, a first electrode 17 and an
associated second electrode 18 for generating an electrostatic field E , and a meter-
ing device 19 for feeding the abrasive particles 10 to a conveyor 20.

The conveyor 20 comprises an endless conveyor belt 21, which is tensioned by
means of two deflection pulleys 22, 23. Deflection pulley 22 is driven in rotation by
means of an electric drive motor 24. A part of the conveyor belt 21 arranged above
the deflection pulleys 22, 23 in relation to the force of gravity F_G forms a conveying
region 25, which extends in a horizontal x direction and a horizontal y direction.

The metering device 19 is arranged ahead of the electrodes 17, 18 in a conveying
direction 26. The first electrode 17 is of plate-shaped design and is arranged below
the upper part of the conveyor belt 21 and below the conveying region 25 in the di-
rection of the force of gravity F_G . In contrast, the second electrode 18 is arranged
above the conveyor belt 21 and the conveying region 25 in relation to the force of
gravity F_G . The second electrode 18 is thus spaced apart from the first electrode 17
in a vertical z direction, with the result that the conveying region 25 extends be-
tween the electrodes 17, 18. The second electrode 18 is secured on the handling de-
vice 16. The x , y and z directions form a Cartesian coordinate system.

The second electrode 18 is shaped to match the main body 2. The main body 2 is
held by means of the handling device 16 in such a way that the second electrode 18
rests substantially over the full area against a rear side of the main body 2. The han-
dling device 16 holds the main body 2 mechanically and/or pneumatically, for ex-
ample. An electric voltage U_E , which is generated and can be set by means of a

voltage source 27, is applied between the first electrode 17 and the second electrode 18.

The adhesive agent 11 is first of all applied on a surface facing away from the second electrode 18, with the result that the adhesive agent 11 arranged on the main body 2 forms a three-dimensionally shaped adhesion surface. The adhesive agent 11 is applied manually, for example, or by means of the handling device 16. The surface of the main body 2 is dipped into the adhesive agent 11 by means of the handling device 16, for example.

The main body 2 is then positioned above the first electrode 17 in the z direction by means of the handling device 16, with the result that the adhesion surface is arranged partially in the electrostatic field E between the electrodes 17, 18. The field lines emanate vertically from the surface of the first electrode 17 and enter the surface of the second electrode 18 vertically, with the result that the field lines run substantially vertically through the adhesion surface.

By means of the conveying device 20, the abrasive particles 10 for the formation of the three-dimensionally shaped abrasive particle layer 12 are transported into the electrostatic field E. For this purpose, the metering device 19 supplies the abrasive particles 10. The abrasive particles 10 are fed to the conveyor belt 21 and distributed thereon in a metered manner by means of the metering device 19. By means of the electric drive motor 24, the conveyor belt 21 with the abrasive particles 10 arranged thereon is moved in the conveying direction 26, thus ensuring that the abrasive particles 10 are brought into the electrostatic field E. The speed of transfer in the conveying direction 26 can be set by means of the electric drive motor 24.

By means of the electrostatic field E, the abrasive particles 10 are moved to the adhesive agent 11 and the adhesion surface counter to the force of gravity F_G , and are aligned along the field lines. When the abrasive particles 10 touch the adhesion surface, they remain stuck there. By means of the adhering abrasive particles 10, the

abrasive particle layer 12 is formed on the main body 2. In order to apply the abrasive particles 10 uniformly and homogeneously, the main body 2 is rotated about a central longitudinal axis 28 by means of the handling device 16.

5 After the abrasive particle layer 12 has been fully applied to the main body 2, the main body 2 with the adhesive agent 11 and the abrasive particle layer 12 forms a semifinished product. The semifinished product is released by the handling device 16 and arranged in a heating device, where the adhesive agent 11 is cured. The top binding 13 and the top layer 14 are then applied to the abrasive particle layer 12 in
10 the usual way. In respect of further details and features of the grinding tool 1 and of the electrostatic application of the abrasive particles 10, attention is drawn explicitly to WO 2018/149 483 A1, the contents of which are incorporated by reference at this point.

15 A second illustrative embodiment of the invention is described below with reference to figures 8 and 9. In contrast to the previous illustrative embodiment, the main body 2 comprises damping particles D. The damping particles D are natural rubber particles and/or foam particles, for example. The damping particles D are incorporated into the main body 2 during the production of the latter. The damping particles
20 D form additional connection-free regions V and themselves have noise- and vibration-damping properties.

The grinding tool 2 furthermore comprises a supporting layer 29, which is connected to the main body 2 and provides a surface for the arrangement of the abrasive
25 layer 2. The supporting layer 29 is composed of a metallic material. The supporting layer 29 is connected monolithically to the main body 2. For this purpose, the supporting layer 29 is produced together with the main body 2. This is illustrated in figure 9. The supporting layer 29 is covered electrostatically with abrasive particles 10 in the manner described before and/or after being connected to the main body 2.
30 In respect of further aspects of the construction, production and operation of the grinding tool 1, attention is drawn to the previous illustrative embodiment.

In general, the following applies:

The grinding tool 1 according to the invention does not have continuous or full-area bonding with the binder within the main body 2, and therefore there are connection-free free spaces or regions within the main body 2, e.g. air inclusions. The main body 2 has a quantity of binder B such that, on the one hand, a relative movement is made possible within the main body 2 but, on the other hand, the main body 2 is sufficiently firm and does not delaminate during grinding. This is achieved by means of insular or fine wetting of the fiber plies F_i . The free relative movement within the fiber plies F_i or the respective fiber ply F_i allows high vibration and noise damping. By virtue of the fiber plies F_i connected to one another by means of the binder B and by virtue of the possible relative movement within the respective fiber ply F_i , a construction of the main body 2 such that there are alternating hard and soft layers is achieved. An additional rubber ply is not required to achieve high vibration and noise damping. The fiber plies F_i moving one inside the other make possible the high vibration and noise damping but ensure that there is no wrinkling. The main body 2 can be produced with any desired three-dimensional shape, in particular by draping the fiber plies F_i and connecting the fiber plies F_i by means of the binder B. The respective fiber ply F_i has a connection on both sides to the binder B, thus ensuring that there is no delamination of the fiber plies F_i . The binder B connects the individual fiber plies F_i , which remain inherently flexible. The binder B is an elastomer, for example, thereby assisting the vibration and noise damping of the main body 2. The at least one fiber ply F_i is padded, for example. The at least one fiber ply F_i is coated, laminated, sheathed or silanized with the binder B, for example. The respective fiber ply F_i is designed as a woven fabric or non-crimp fabric. The fiber plies F_i within the main body 2 are designed as woven fabrics and/or non-crimp fabrics. The woven fabric has a twill weave, for example. A twill weave ensures movement or mobility within the woven fabric and simplicity of draping. The fiber plies F_i are arranged as inner fiber plies and/or outer fiber plies in the main body 2. The abrasive layer 3 can comprise an abrasive particle layer 12 or an abra-

sive fleece. The abrasive particle 10 is a coated ceramic particle, for example. The supporting layer 29 serves as an intermediate layer between the main body 2 and the abrasive layer 3. The supporting layer 29 can be designed as paper, film and/or woven fabric. The supporting layer 29 is composed of a metallic material, for example.

- 5 Abrasive particle 10 is preferably applied directly to the main body 2 or the supporting layer 29.

Patent claims

1. A grinding tool comprising

- a main body (2) having

-- a binder (B),

-- at least one fiber ply (F₁ to F₄) embedded in the binder (B), and

- an abrasive layer (3),

characterized

in that the at least one fiber ply (F₁ to F₄) is arranged in the binder (B) in a partially movable manner.

2. The grinding tool as claimed in claim 1, **characterized**

in that each fiber ply (F₁ to F₄) comprises a plurality of yarns that are embedded in the binder (B) in a partially movable manner relative to one another.

3. The grinding tool as claimed in claim 1 or 2, **characterized**

in that the main body (2) comprises a plurality of fiber plies (F₁ to F₄) that are embedded in the binder (B) and are movable relative to one another in some region or regions.

4. The grinding tool as claimed in at least one of claims 1 to 3, **characterized**

in that the main body (2) comprises a plurality of fiber plies (F₁ to F₄) having a plurality of yarns, and the yarns are embedded in the binder (B) in a partially movable manner relative to one another.

5. The grinding tool as claimed in at least one of claims 1 to 4, **characterized**

in that the at least one fiber ply (F₁ to F₄) comprises at least one woven fabric and/or at least one non-crimp fabric.

6. The grinding tool as claimed in at least one of claims 1 to 5, **characterized**

in that the main body (2) comprises a number N of fiber plies (F_1 to F_4), wherein: $1 \leq N \leq 12$, in particular $2 \leq N \leq 10$, and in particular $4 \leq N \leq 8$.

7. The grinding tool as claimed in at least one of claims 1 to 6, **characterized**
5 **in that**, for a ratio M of a mass m_B of the binder (B) to a mass m_F of the at least one fiber ply (F_1 to F_4), the following applies: $1/25 \leq M \leq 1/2$, in particular $1/20 \leq M \leq 1/3$, in particular $1/15 \leq M \leq 1/4$, and in particular $1/12 \leq M \leq 1/6$.
8. The grinding tool as claimed in at least one of claims 1 to 7, **characterized**
10 **in that** the main body (2) comprises damping particles (D), in particular rubber particles and/or foam particles.
9. The grinding tool as claimed in at least one of claims 1 to 8, **characterized**
15 **in that** the binder (B) is an organic adhesive, in particular phenolic resin, epoxy resin and/or natural rubber.
10. The grinding tool as claimed in at least one of claims 1 to 9, **characterized**
in that the main body (2) is of curved design.
- 20 11. The grinding tool as claimed in at least one of claims 1 to 10, **characterized**
by a supporting layer (29), which is connected to the main body (2) and on which the abrasive layer (3) is arranged.
12. The grinding tool as claimed in at least one of claims 1 to 11, **characterized**
25 **in that** the abrasive layer (3) is shaped three-dimensionally.
13. A method for producing a grinding tool having the following steps:
 - preparing at least one fiber ply (F_1 to F_4) and a binder (B),
 - producing a main body (2) by heating and then cooling the binder (B),30 wherein the at least one fiber ply (F_1 to F_4) is arranged in a partially movable manner in the binder (B) after cooling, and

- forming an abrasive layer (3).

14. The method as claimed in claim 13, **characterized**

in that a plurality of fiber plies (F_1 to F_4) are used to produce the main body (2).

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15. The method as claimed in claim 13 or 14, **characterized**

in that the heating of the binder (B) takes place under pressure.

16. The method as claimed in at least one of claims 13 to 15, **characterized**

10 **in that** preparation takes place in such a way that the at least one fiber ply (F_1 to F_4) is provided with the binder (B) on one side and/or in some region or regions on two sides.

17. The method as claimed in at least one of claims 13 to 16, **characterized**

15 **in that** preparation takes place in such a way that a first fiber ply (F_1 , F_4) without binder (B) is arranged adjacent to a second fiber ply (F_2 , F_3) provided with binder (B).

18. The method as claimed in at least one of claims 13 to 17, **characterized**

20 **in that** preparation takes place in such a way that the at least one fiber ply (F_1 to F_4) is arranged adjacent to a layer of binder (B).

19. The method as claimed in at least one of claims 13 to 18, **characterized**

in that a supporting layer (29) is arranged on the main body (2).

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20. The method as claimed in at least one of claims 13 to 19, **characterized**

in that the formation of the abrasive layer (3) is performed by electrostatic application of abrasive particles (10).