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COMPOSITE ABRASIVE PRODUCTS

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(56) Prior Art Documents
EP 318168

(57) Claim

1. A composite abrasive product comprising a random non-woven fibrous web with abrasive particles adhered thereto by means of an organic polymer characterized in that the abrasive particles are shaped particles of an abrasive material having a substantially uniform cross-sectional shape along a longitudinal axis and an aspect ratio of at least 1.5:1.

8. A composite abrasive wheel comprising a random non-woven fibrous web with seeded sol-gel alumina abrasive particles having a grit size of 150 or smaller adhered thereto by means of a polyurethane binder characterized in that the abrasive particles are shaped particles with a substantially uniform cross-sectional shape along a longitudinal axis and an aspect ratio of from about 2:1 to about 6:1.

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(54) Title: COMPOSITE ABRASIVE PRODUCTS

(57) Abstract

Composite abrasive wheels having shaped abrasive grits bonded to a fibrous substrate are more effective than their counterparts with irregularly shaped grain, especially at finer grit sizes.

COMPOSITE ABRASIVE PRODUCTS

BACKGROUND OF THE INVENTION

Composite abrasive products, such as wheels or abrading pads, are formed by adhering abrasive particles by means of an organic polymer to the fibers of a nonwoven fiber web. Multiple plies of such webs are then laminated to form a slab from which the products may be cut or the web may be wound spirally to form a log from which products in the form of wheels may be cut. Applications of these widely used abrasive products, usually referred to as "composite abrasives", include polishing, deburring, finishing, and cleaning of metallic parts. They may also find extensive applications in the finishing of wooden furniture.

The abrasive grit is most frequently fused alumina but other grits such as silicon carbide, fused alumina/zirconia and sol-gel alumina abrasive grits have been proposed.

The most commonly used organic binder for use in composite wheels is a polyurethane such as is described for example in USPP 4,011,063; 4,078,340; 4,609,380; 4,933,373 and 5,290,903. Other binders that may be used include acrylic polymers, phenolic resins, melamine resins, polyvinyl chloride and polyvinyl acetate.

DESCRIPTION OF THE INVENTION

The present invention provides a novel composite abrasive comprising a random non-woven fibrous web with abrasive particles adhered thereto by means of an organic polymer characterized in that the abrasive particles are shaped particles of an abrasive material having a substantially uniform cross-sectional shape along a longitudinal axis and an aspect ratio, defined as being the ratio of the length to the greatest dimension perpendicular to that length, of at least 1.5:1.

The material from which the abrasive particles are made can be for example alumina, silicon carbide, alumina/zirconia or any other suitable abrasive that can

be formed into shaped particles. The preferred material is a sol-gel alumina formed by a process in which a sol or a gel of an alpha alumina precursor is dried and then fired to convert the precursor to the alpha phase. The precursor may be modified by the presence of seed particles, which generate an extremely fine crystal microstructure, and/or other modifiers known in the art such as magnesia; zirconia; rare earth metal oxides such as lanthana, ceria, samaria and the like; transition metal oxides such as titania, yttria, chromia, iron oxide, cobalt oxide, nickel oxide and manganese dioxide; and silica.

The shaped abrasive grits used in the invention can be made by extrusion or molding of a dispersion of the precursor material, usually in water, and then firing the shaped particles with the desired configuration to convert them to the final abrasive particles.

The shape is frequently and most conveniently basically a right cylinder though other cross-sectional shapes such as triangles, squares, polygons and ovals may often give desirable results. While the cross-sectional shape is consistent, the dimensions may vary to permit a pyramid, truncated cone, needle or other regular shape maintaining a uniform cross-sectional shape may be used.

The abrasive particles may have any desired grit size that is adapted to use with composite abrasives. It is however found that the advantages derived from the use of shaped abrasive grits as taught in this invention are most apparent when the grits are smaller such as from about 120 grit and smaller and more preferably from about 150 grit to about 400 grit. The grit size as used in this specification is measured according to the standard FEPA grits with the largest cross-sectional dimension perpendicular to the length providing the measuring dimension for passage through the apertures of a sieve. The aspect ratio of the abrasive particles can be from about 1.5:1 to about 25:1 but usually the most convenient range is from about 1.5:1 to about 10:1 and more

preferably from about 2:1 to 6:1.

The composite abrasive wheels of the present invention may be prepared by appropriate techniques which are well known in the industry. The wheels are typically in the form of a disc or cylinder having dimensions required by end users. The matrix of the abrasive wheels may be either a nonwoven fibrous web or a foamed organic polymer with or without reinforcement.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is further illustrated by the following non-limiting examples, wherein all parts are by weight unless otherwise specified.

EXAMPLE 1

A 9.4 mm thick, low density, non-woven, fibrous web weighing 95 g/m^2 was formed from 15 denier nylon 6-6 fibers on a web-forming machine. The resulting low density web was sprayed with a prebond binder to provide a dry add-on weight of between 40 - 48 g/m^2 using a spraying mix consisting of 55.9% styrene-butadiene latex (sold under the trade name "Tylac 68132" by Reichold Co.), 31.1% water, 10.5% melamine resin (sold under the trade name "Cymel 385" by American Cyanamide Co.), and trace amount of surfactant and acid catalyst. The prebond binder was cured to a tack-free state by passing the sprayed web through a convection oven maintained at 148.8°C for a dwell time of 3.3 minutes. The resultant prebonded nonwoven web was about 8 mm thick and weighed about 128 g/m^2.

An adhesive binder (called first pass binder hereafter) consisting of 28.5% water, 29.2% of a phenolic resin binder available from Bendix Corporation under the trade name BM-11, 0.1% of a defoamer, and 29.1% of Alpine talc as an inorganic filler was used as a saturant for the prebonded web at the dry add-on weight of 1.6 g/m^2. While the binder was still tacky abrasive particles were gravity fed to the surface of the web so that the particle stuck to the binder. The add-on abrasive weight was 0.8 gm/m^2. The adhesive binder was cured to a tack-

free state by passing the saturated web through a convection oven maintained at 160°C for a dwell time of 8 minutes. The resultant web was about 6.4 mm thick and weighed about 3.3 g/m^2.

Sections of the abrasive/binder saturated web were then saturated again with another abrasive/binder mix (called second pass binder hereafter) and partially dried to produce layers called "slabs" for lamination to form composite abrasive wheels.

Fourteen 275 mm square sections of partially dried slabs with the same type second pass binder, were laminated by being placed between two metal plates and compressed to a thickness of 25.4 mm. Then the whole assembly was placed in an oven maintained at 121°C for one hour. At the end of one hour the metal plates were removed and the cure was continued for another 16 hours. After allowing the cured laminated slabs to cool to room temperature, wheels having a 248mm diameter and 32mm center hole were die cut from the 25mm thick laminated slabs.

Four sets of wheels were produced to compare the performance of the shaped grits from a seeded sol-gel alumina having an aspect ratio of 3:1 against a standard fused alumina grit at two different grit sizes. Basically the same production process was used for each except that a different binder was used at the different grit sizes.

The wheels, identified in Table I, were evaluated for grams of metal cut and grams of abrasive grain shed during the cut. The wheels were mounted on the shaft of a Floor Lathe Belt grinding machine adapted to receive the wheels which are mounted on a horizontal shaft driven by a 5 horse power motor. The wheel shaft is driven at 1800 rpm.

A second horizontal driven shaft, parallel to the first, is adapted to receive a cylindrical test piece with a 90mm outside diameter x 83mm inside diameter x 90mm in length and to be urged in the direction of the

first shaft by a dead weight of 1362gm such that the outside diameter of the test piece comes into contact with the wheel being tested. During testing the test piece is also reciprocated in the direction of the axis of rotation to ensure that essentially all parts of the outside diameter are contacted with the wheel.

The test piece is roatated at 9 rpm in the same direction as the wheel and two contact periods of 15 minutes are allowed. The test piece is removed after each period tohave its weight and surface finish checked. The test wheel is also measured for reduction in outside diameter.

The result are set forth in Table 1 below.

TABLE 1

GRAIN	GRIT SIZE	BOND USED	CUT (GM)
SHAPED SG	180	V-8020	10.4
FUSED A/O	180	V-8020	1.4
SHAPED SG	120	V-B635	2.8
FUSED A/O	120	V-B635	1.5

The resins used as the binders were polyurethanes obtained from Uniroyal Chemical Company under the trade designation "Vibrathane" with the indicated descriptor. The shaped grains had a cylindrical cross-section and an aspect ratio of 3:1.

From the above data it can be seen that the wheel with the shaped abrasive particles cut much more aggressively than the standard fused alumina wheels.

The claims defining the invention are as follows:

1. A composite abrasive product comprising a random non-woven fibrous web with abrasive particles adhered thereto by means of an organic polymer characterized in that the abrasive particles are shaped particles of an abrasive material having a substantially uniform cross-sectional shape along a longitudinal axis and an aspect ratio of at least 1.5:1.

2. A composite abrasive product according to Claim 1 in which the abrasive particles comprise a sol-gel alumina.

3. A composite abrasive product according to Claim 2 in which the sol-gel alumina has an alpha alumina crystal size less than one micron.

4. A composite abrasive product according to any one of Claims 1 to 3 in which the grit size of the abrasive particles is less than 150 grit.

5. A composite abrasive product according to any one of Claims 1 to 4 in which the shaped abrasive grains have a generally circular cross-section shape.

6. A composite abrasive product according to any one of claims 1 to 5 in which the aspect ratio is from about 2:1 to about 6:1.

7. A composite abrasive product according to any one of claims 1 to 6 in the form of a wheel.

8. A composite abrasive wheel comprising a random non-woven fibrous web with seeded sol-gel alumina abrasive particles having a grit size of 150 or smaller adhered thereto by means of a polyurethane binder characterized in that the abrasive particles are shaped particles with a substantially uniform cross-sectional shape along a longitudinal axis and an aspect ratio of from about 2:1 to about 6:1.

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NORTON COMPANY,
By its Patent Attorneys,
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(Bruce Wellington)

INTERNATIONAL SEARCH REPORT

Inter nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B24D3/28 B24D5/08 B24D13/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B24D B24B C09K E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 318 168 (MINNESOTA MINING AND MANUFACTURING COMPANY) 31 May 1989 see abstract see page 4, line 34 - page 5, line 30 see claims 1,2,9; example 4	1,2
P,X	WO,A,95 01241 (MINNESOTA MINING AND MANUFACTURING COMPANY) 12 January 1995 see page 14, line 30 - page 15, line 10 see page 19, line 3 - line 4 see page 26, line 33 - page 27, line 36 see page 29, line 18 - line 28 see page 35, line 30 - line 32 see claims 3,7,18	1,2,5,8

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 1995	31. 10. 95
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	**Authorized officer** Molto Pinol, F

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/08556

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 269 (M-723) 27 July 1988 & JP,A,63 052 971 (DAITOO K.K.) 7 March 1988 see abstract	1,5,7
A	DATABASE WPI Section Ch, Week 9114, Derwent Publications Ltd., London, GB; Class ALG, AN 91-098582 C14! & JP,A,3 043 156 (TOKYO DIAMOND KOGU) 25 February 1991 see abstract	1,7,8
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 335 (M-856) 27 July 1989 & JP,A,01 115 576 (SANKYO RIKAGAKU K.K.) 8 May 1989 see abstract	1,7

INTERNATIONAL SEARCH REPORT

information on patent family members

Inter nal Application No
PCT/US 95/08556

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		CA-A-	1297304	17-03-92
		DE-D-	3852752	23-02-95
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