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ABRASIVE ARTICLES AND METHOD OF
MAKING THE SAME

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This invention relates, in general, to articles of manufacture of the type having a support and a layer of comminuted solid materials deposited and secured thereon; and more particularly to improvements in securing and maintaining a physical union of the comminuted material to its support.

The invention is particularly directed to the coating of supports such as strips or sheets of fabric, paper, or the like, with abrasive particles or granules and the application of their securing means for adherence thereto to make abrasive articles.

This application is a continuation-in-part of our copending application Serial No. 179,338, filed December 11, 1937, now Patent No. 2,269,415.

Composite structures of the abrasive type such as sandpaper or emery cloth comprise generally, (a) a base of sheet material, which may be felted as in the case of paper or woven as in the case of cloth (b) a more or less finely comminuted resistant material having abrading properties, such as garnet, corundum, or the like, and (c) a binder generally in the form of a glue or resinous bond which serves to bind the abrasive to the base.

The manufactured abrasive articles known to us have at no time in the past ever been made so that all abrasive particles are coated and held in a durable matrix or solidified adhesives in such a manner that substantially all of the particles have an opportunity of rendering full utility.

The abrasive particles, to be firmly secured, require an additional bond or a plurality of bonds to anchor them to the adhesive on which they are coated. This additional bonding gives the finished abrasive article additional strength and utility, but in so doing, and in the methods of present use and their adaptation, a great percentage of the orientation and perpendicular erection of the abrasive particles is destroyed. Generally this destruction or changing of position of the particles may be described as due to the disturbing forces of a later applied bonding means, tending to pull the granule, loosened by a softening of the original binder, from its original position.

With the present type of application of oriented granular particles to an adhesive bond, a particular need is present of maintaining the granules in an oriented position for the purpose of

producing maximum shearing effect of the working article. By orientation of an abrasive granule, we mean a disposition of the granular material coated on a bonding surface in such a manner that the longer dimensional configuration of the granular material is placed approximately perpendicular to the bond. Present methods of applying oriented particles are amply illustrated by electrostatic means as described in the patent to J. S. Smyser, No. 1,788,600.

Our invention is not concerned with the problems of applying the abrasive particles in a particular manner to the base material, but is concerned primarily with the provision of a combination of individually distinct and separate adhesive coatings co-operatively maintaining the particles in the original position obtained in their first application to the base. This position is preferably such that the particles are oriented so that a substantial proportion of their pointed abrasive surfaces are exposed, or at least such that particles are disposed with the long dimensions thereof at a substantial angle to the base.

It is therefore a principal object of this invention to secure a maintenance of orientation of abrasive particles adhering to a primary or making adhesive coated on a base, during and after application of a second anchoring adhesive coating.

Another object of this invention is to provide an abrasive article having a better cutting edge due to coating of the particles in such a manner as to maintain them in an oriented position throughout the finishing process.

A further object is to provide for maintaining orientation of the abrasive particles on abrasive articles both as to those having a substantially rigid backing and those having a flexible backing; and the invention is applicable to preparing abrasive articles both for dry abrasive work and wet abrasive work.

In addition, we have further found that the application of the bonding materials in accordance with our invention results in an abrasive article having increased life and durability, as well as a strengthened granular bond.

In accordance with the present invention, the primary or making coat of adhesive (upon which the comminuted solid material is deposited as a layer or coating), and the second anchoring or

sizing coating of adhesive (applied after the comminuted solid material), are of such nature with respect to each other as to prevent the application of the anchoring binder coating from loosening the bond between the primary adhesive and the comminuted material. However, after application of some of the type adhesives as herein-after expressed, a slight softening effect may be produced by heat treatments or the like, tending to fuse the bonds. Such slight softening effect does not destroy the oriented position of the granule, but tends to provide a more stable bond between dual binding means.

The nature of the invention will be apparent in more detail from the following examples and descriptions by which it is illustrated:

1. A glue-resin adhesive is made up consisting of:

	Parts
Glue	74
Phenol-aldehyde resin	82
Water	66
Urea	13
Concentrated ammonia	24
Cellosolve (ethylene glycol monoethyl ether)	16

This adhesive composition is coated on a backing material such as cloth, paper, or the like, as the primary or making coat. Abrasive granules are then oriented or coated on this adhesive and left to dry at room temperature for approximately 20 minutes. The sheet so dried is then coated with a phenol-aldehyde resin solution which consists of:

	Parts
Phenol-aldehyde resin	60
Cellosolve	40

again dried as above. The solvent "Cellosolve" used in this second anchoring adhesive has no effect on the primary bond to the extent of causing the abrasive mineral to lose its oriented position, the primary bond having been insolubilized to any mono-constituent solvent by evaporation of the solvents water and Cellosolve.

2. Another example of the use of this principle of coating is to insolubilize a coating of adhesive through direct chemical reactions, such as by a tanning reaction, or by heating. In this case, for example, a coating of glue of the usual type is applied to the abrasive backing and then the abrasive material is coated to the adhesive. The glue-coated backing with abrasive thereon is then passed into a formaldehyde gas-filled chamber wherein the glue is converted from a film soluble in water to one insoluble in water. A second coating of glue is then applied as an anchoring means for securing the abrasive material over the original glue film. In place of the specific formaldehyde gas there may be substituted para-formaldehyde, furfural, acetaldehyde, or the like; or if this type of treatment is not desirable, the adhesive may be mixed with or treated after application in a bath of tannic acid or its salts, picric acid or its salts, chrome alum, sodium dichromate, dichromic acid or its salts, titanium oxide, stannous chloride, hexamethylenetetramine, or the like, any and all of which will render the adhesive substantially water-insoluble and weather-resistant. The anchoring bond subsequently added has no effect on the original position of the mineral particles because the solvent of the second coating does not affect the primary securing means. To render the anchoring bond water-insoluble, the article may again

be passed into the formaldehyde chamber or be otherwise treated as heretofore mentioned.

3. Similar results are obtained where a resin, for example a phenol-aldehyde or heat-advancing resin soluble in the alcohols as methyl and the like or ketones as acetone or organic esters as ethyl acetate, etc., is used as a primary coat on a backing. The mineral is coated directly on the adhesive phenol-aldehyde surface. Sufficient heat is then directed on the mineral coated backing to volatilize the solvent and polymerize the resin. The temperature employed generally will run from 150° F. to 225° F. or higher as applicable to the materials used. The time varies from 20 minutes to several hours depending upon the amount of resin coated and the temperature used. Having accomplished a partial polymerization of the resin, we are then able to add additional resin in the form of an anchoring adhesive without affecting orientation because the resin once properly set up will not be further affected by the solvents in the anchoring coat, with a like treatment to set up this anchoring means. The subsequent heating may slightly interfuse the interfacial surfaces of this type bond without a destruction of the granular positioning.

4. Another example of the type bonding materials which we propose using is a primary adhesive coating applied as a base or binder for disposition of abrasive granular mineral, for example glue and resin soluble, e. g. in alcohol and water, which can be, by heat treatment as is commonly known to the trade, hardened sufficiently to hold the granules in place, and then a coating of a resin such as Bakelite, or other phenol-aldehydes or heat-advancing resins, or styrene, vinylite resins and the like, which contains no solvent and is normally liquid at room temperature, is applied over the granules and the coated article is then subjected to a temperature which will polymerize or set up the resin beginning at approximately 110° F. and not exceeding the limit at which carbonization takes place.

5. Other methods of accomplishing a maintenance of orientation include use of a hydrophylic primary casein binder adhesive and an anchoring adhesive of a phenol-aldehyde resin in organic solvents which do not dissolve the casein binder; a sodium silicate primary binder adhesive soluble in water and a resin anchoring size as chloroprene, vinyl derivative, or the like applied in a liquid state and polymerized, for example, by heat and pressure, light, or a catalyst such as oxygen or a peroxide. An additional illustration is the application of a phenol-aldehyde resin soluble in ethylene glycol monoethyl ether which serves as a good primary coating and maintains orientation well when employed in conjunction with N-propyl methacrylate polymer solution in benzene used as an anchoring adhesive.

In addition to the above enumerated examples, use may be made of an anchoring adhesive (such as a resin) in an organic solvent, which may be any ketone, poly ether, ester, ethyl alcohol, methyl alcohol, furfuran derivative, any chlorinated solvent or any other organic solvent or mixture of organic solvents in conjunction with a primary binder adhesive or bond dissolved in water, but not soluble in the particular solvent used in the anchoring adhesive. Conversely, we may make use of an anchoring adhesive dissolved in water and a water-insoluble primary binding bond dissolved in an organic solvent as of the above character. These possibilities are illustrated by the use of a blood albumin anchoring adhesive in

water and a primary resin binder adhesive soluble in a hydrocarbon of the above character; by a primary casein glue binder adhesive in water and a resin anchoring adhesive in an organic solvent, such as ether alcohols, esters, and the like, in which the glue is insoluble; and by water-soluble soybean protein glue as the primary binder adhesive and a resin anchoring means in an organic solvent, such as benzene, ether, alcohol and the like, in which the soy protein is insoluble; any and all of which coatings may be used in vice versa or interchangeable form as contemplated by this improved combination of bonding means.

Further, by way of illustration, we may use an anchoring adhesive dissolved in an organic solvent and a primary binder bond dissolved in another organic solvent, but not soluble in the particular solvent used in the anchoring adhesive. As an example of this type of bonding means, in addition to those already given, we may use a primary binder coating of a proteide type, such as zein or the like, in alcohol, and a resin anchoring coating having an organic solvent in which the primary binder is insoluble such as benzene, ether, chlorinated methane, and the like.

As an alternative method of applying coatings dissolved in the same solvent, we have found that we may apply the granules to a primary adhesive coating and then by the use of a thin interposed covering of material such as a sulphonated rubber (for example an "acid seal primer" which is a commercial preparation of sulphonated rubber made by Goodrich), with or without a modifier, applying a sizing coat dissolved in the same solvent as the binder coat to secure a finished product with the granules in an oriented position. With the addition of this thin coating and sealing material, we have in reality applied three films for securing the abrasive granules and find that it is possible, by the use of the intermediate sealing layer (such as that previously mentioned or any equivalent layer which will meet the requirements of preventing the anchoring coating from attacking the primary or making coat and of securing a good intermediate cohesion between the making and the sizing bonds), to interchangeably use the bonding means in any form or combination desired, whether dissolved in a like solvent or not.

By the methods as herein disclosed, the primary binder and anchoring coats are co-operatively distinct in the product, although adhering or bonded together at the interface without destroying the granular position.

In general, it is our desire to use the examples illustrated in any combination which will accomplish the purpose of our invention, or any substitutes thereof which by nature have characteristics for accomplishing the results herein described; and while we have described more or less specifically the application of certain coatings, it will be readily understood that other combinations of adhesives may be applied for the purpose of securing maintenance of orientation.

Furthermore this application is not limited to the combination of adhesive coatings specifically illustrated above, and contemplates broadly the use of particular advantageous resinous and adhesive materials as a bond or binder for abrasive grits. For example, acrylic resins have been found by us to have special advantages in bonding abrasive grits. In addition to the polymerized acrylic ester given herein above, we may use as a bond for abrasive grits (or as a presize or the like

in the case of coated abrasives) other acrylic resins, of which polymers of N-butyl methacrylate, iso-butyl methacrylate, ethyl methacrylate and methyl methacrylate, and copolymers made from such compounds are important examples. The copolymers may be of any two or more monomers of the materials named, or between a monomer or partial polymer of any one of the acrylic materials hereinabove set out and another acrylic monomer or partial polymer and/or a vinyl monomer, or other comparable polymerizable materials, for controlling hardness and/or other properties, as desired. The control of hardness of acrylic acid resins (such as methacrylate ester polymers, etc.) by copolymerization has, in a general way, long been well known in the resin art. For example, see generally "The Chemistry of Synthetic Resins" by Ellis (1935), page 1076 etc.; British Patent No. 374,436 of 1931; "Chemical Abstracts," 1934, vol. 28, page 4379; "Synthetic Resins and Their Plastics" by Ellis (1923), page 304 and footnotes; etc. Hardness can also be controlled by the use of plasticizers, especially those known in the resin art with which the acrylic resin is compatible but may or may not be actually soluble. Where a plasticizer is used in which the acrylic resin is not actually soluble, in addition to avoiding undue hardness of the bond, this aids in producing an abrasive article which tends to maintain or return to its original shape or form. The proper order of hardness in any case is well known to those familiar with the manufacture of abrasive articles, e. g. sandpaper.

We also advantageously control hardness, flexibility or other properties of methacrylates, ethacrylates or other acrylic resins by blending or homogenizing the same, in any suitable manner well known to resin chemists, with other resinous materials including vinyl chloride-acetate copolymers, chlorinated rubber, e. g. "Tornesite," and/or cellulose nitrate, or with rosin, certain phenol aldehyde resins, coumaroneindene resins and/or chlorinated diphenyl, for example, choosing the blending agent or resin and proportion thereof in any case so as to secure desired uniformity. Also acrylic resins may be flexibilized for use in abrasive articles such as sandpaper by the use of such plasticizers as dibutyl phthalate, dicyclohexyl phthalate, dibutoxyethyl phthalate, dibutoxyethoxyethyl phthalate, triethylene glycol dihexoate, and the six to twelve carbon branch chain secondary alcohol carbamates. Materials such as methyl abietate may also be used with many acrylic resins.

The acrylic resins may be employed with or without solvents but solvents are often desirable. Suitable solvents include Cellosolve, aromatic hydrocarbon esters, ketones, ethers, and chlorinated hydrocarbons.

While we have described and illustrated our invention in various details, we do not limit ourselves thereby. All novel subject matter disclosed and/or embraced within the scope of the appended claims is comprehended as our invention.

What we claim is:

1. As a new article of manufacture, abrasive grains bonded with a polymerized ester of alkyl substituted acrylic acid.

2. As a new article of manufacture, an abrasive article of the coated abrasive type comprising abrasive grains bonded with a polymerized mono-hydric alcohol ester of alkyl substituted acrylic acid.

3. As a new article of manufacture, a coated

abrasive article comprising abrasive grains bonded with a copolymer of a vinyl ester and a polymerizable ester of an alkyl substituted acrylic acid.

4. As a new article of manufacture, sandpaper having abrasive grains bonded with an adhesive composition including N-propyl methacrylate.

5. As a new manufacture, an abrasive article

including a sandpaper backing and comprising abrasive grains bonded and anchored thereto with an adhesive composition including a polymerized ester of an alcohol and an alkyl substituted acrylic acid.

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DISCLAIMER

2,357,348.—*George P. Netherly* and *Bert S. Cross*, St. Paul, Minn., and *Gilbert R. Anderson*, Wilmington, Del. ABRASIVE ARTICLES AND METHOD OF MAKING THE SAME. Patent dated Sept. 5, 1944. Disclaimer filed July 18, 1947, by the assignee, *Minnesota Mining & Manufacturing Company*.
Hereby enters this disclaimer to claims 1, 2, 3, and 5 of said patent.
[*Official Gazette August 26, 1947.*]