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COATED ABRASIVE ARTICLE AND METHOD OF MANUFACTURE

Royden C. Rinker, Alliance, and Herbert W. Schnabel, Homeworth, Ohio, assignors to Armour and Company, Chicago, Ill., a corporation of Illinois

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This invention relates to an improved coated abrasive article and to a method for producing it. In its principal aspect, this invention relates to an improved sheet abrasive for use in abrading surface coatings, plastics, soft alloys and the like.

The problem of abrading surface coatings, plastics, soft alloys and the like has plagued industry since the first time it was attempted. The difficulties are not caused by any resistance to cutting, but rather by an extreme inclination to "load" the cutting edges with waste removed from the material being abraded. Coatings such as fillers, sealers, primer coats of paints and the like when abraded become gummy, causing a clogging of the abrading material and shortening its useful life long before all of the inherent cutting ability of each edge or point of abrasive grain has been completely used. In the case of plastics and soft alloys, loading is caused by the high ductility and weldability of these materials on being abraded, both to themselves and to the abrasive grains. Obviously, loading increases the cost of the abrading operation and is undesirable for this reason if no other.

Numerous materials have been used in the past in an attempt to solve this problem, as for example greases, waxes, oils, talc and graphite. However, none of these has been completely acceptable, either for reasons of low efficiency or actual failure to prevent gumming and loading. The most recent attempt at a solution to this problem is described in British Patent No. 712,718 to Behr-Manning, wherein an unfused loosely held coating of small particles of a water-insoluble soap, such as zinc stearate, is applied to the abrasive surface. While these materials have proven satisfactory in the reduction of loading, the answer has not been a complete one, especially in those instances where surface coatings are abraded before receiving a finishing coat. One difficulty encountered is the transference of the loading-preventing material to the surface being abraded due to its being very loosely held. In most instances, unless removed through washing or the like, this material interferes with the adhesion of the subsequent coating. This has always been accepted as the lesser evil and a necessary adjunct to any substantial reduction in loading upon the theory that extensive mixing between the loading-preventing material and the cuttings is necessary to accomplish the desired result.

In accordance with the present invention, we have provided an improved coated abrasive article which has excellent resistance to loading when used on surface coatings, plastics, soft alloys and the like, and which resists contamination of the surface being abraded. Our improved coated abrasive article consists of a flexible base material having coated on one side thereof an adhesive material having abrasive grains embedded therein. Superimposed on this is a continuous film of a resin having uniformly dispersed therein small solid particles of a water-insoluble metallic soap of a saturated fatty acid having from 16 to 18 carbon atoms. The resin film contains between about 1 and 20 parts by weight of metallic

water-insoluble soap per part of resin, there being between about 1 and 40 milligrams of said film per square inch of surface area.

The flexible base material employed in our improved coated abrasive article can be any conventional material such as paper and cloth, both treated and untreated. A particularly preferred base material consists of a paper treated in the beater stage of manufacture with from about 5 to 20 percent by weight of a rubber latex. Several types of rubber latex can be employed, as for example, natural rubber, butadiene-styrene latex, neoprene, butadiene-acrylonitrile latex, and the like. A preferred rubber latex is a butadiene-acrylonitrile latex having a high percentage of acrylonitrile, as for example, from 30–50 mol percent of acrylonitrile. Through the addition of this rubber latex in the beater stage, that is, addition to the pulp before formation of the sheet, the latex coagulates when the paper web is dried at points where individual fibers in the paper cross over one another. This results in a paper having a much greater flexibility than the ordinary papers used for abrasive backings. The advantages of this paper are flexibility in the hands of the operator, and a high resistance to peeling of the grain layer from the base sheet when the sheet is rubbed over curved surfaces and sharp edges. Further, because of the rubber, the operator is able to obtain a much better grip on the back of the paper and consequently his hand will not slide off the sheet very easily.

The adhesive used to bind the abrasive grains to the paper base is preferably one which is fairly flexible when dried; that is, one which will not crack and/or peel from the base. Examples of such adhesives include animal glue, varnishes, thermoplastic resins and combinations of animal glue and thermosetting resins. We prefer to employ a binder adhesive which is composed of animal glue and contains between about 5 and 25 weight percent of glycerine, based on solids content. This is a flexible adhesive layer which, in conjunction with the flexible rubber-modified paper results in an abrasive coating which will not peel from the paper backing. Although the paper does not have a barrier coat, there is a concentration of rubber on one surface of the sheet. This surface is the one on which the grain is coated. The concentration of the rubber functions in the same manner as a barrier coat by preventing penetration of the glue maker coat into the sheet and by providing excellent adhesion of the glycerine modified adhesive.

The abrasive grains employed in our improved coated abrasive article can be any conventional abrasive such as artificially fused aluminum oxide, silicon carbide, or natural abrasive grains such as flint, garnet, emery and the like. The grit size can vary widely between 500 and 16, depending upon the use to which the finished product is to be put.

A significant feature of our improved coated abrasive article is a continuous film over the abrasive surface of a resin having uniformly dispersed therein small solid particles of a water-insoluble soap of a saturated fatty acid having from 16 to 18 carbon atoms. The resin which we prefer is ethyl cellulose, although other resins of a similar type, such as the polyacrylates, the polymethacrylates, vinyl resins, other cellulose derivatives as are contained in lacquers, and the like can be employed. The resin material comprises between about 5 and 50 percent by weight of the total film. When an inert filler or extender is employed with the resin, the resin content can be as low as about 6% by weight and as high as about 40%. When no filler is employed, the resin content of the film will be between about 15 and 35% by weight.

The metallic water-insoluble soap of a saturated fatty acid containing between 16 and 18 carbon atoms em-

ployed in our improved coated abrasive article is preferably zinc stearate, preferably in relatively pure form, although other materials of the same general nature can be employed, as for example, calcium stearate, lead stearate, barium stearate, strontium stearate, magnesium stearate, aluminum stearate, cadmium stearate, the corresponding palmitates, or mixture of any of the foregoing materials. The water-insoluble soap will constitute between about 50 and 95% by weight of the continuous film, preferably between about 55 and 75% by weight of the film. The quantity of water-insoluble soap applied in admixture with the resin to the abrasive surface will be sufficient to provide between about 1 and 40 mg. of film per square inch of surface area, preferably between about 8 and 25 mg. per square inch. These quantities are optimum for products having grit sizes varying between 500 and 80. It will be appreciated that larger quantities will be applied to surfaces having coarser grits and lesser quantities to surfaces having finer grits.

The continuous film of resin containing the dispersed small solid particles of water-insoluble soap in combination with the flexible base material containing a rubber latex added in the beater stage of manufacture provides an improved coated abrasive article which has a greatly increased operating life, especially when it is used on articles having sharp projections and corners, as compared to abrasive articles heretofore known and used for similar purposes.

In the manufacture of our improved coated abrasive article the paper, preferably as hereinbefore defined, is coated with an adhesive and abrasive grits applied in the conventional manner. After the adhesive containing the abrasive has hardened or dried sufficiently, the sheet is then coated with a dispersion of the selected metallic water-insoluble soap in a volatile organic liquid having also dissolved therein a resin as described above. The dispersion can be applied by any conventional method such as by spraying, roller coating, brushing, etc., so long as the required amount is applied to the abrasive surface. A convenient method for large scale commercial production is by roller coating. The volatile liquid employed as the solvent for the resin and dispersion medium for the metallic water-insoluble soap is one which will not have a deleterious effect on the adhesive coat used to bond the abrasive grit, and which can be easily volatilized after application. Examples of such organic liquids include alcohols, ketones, esters, hydrocarbons and mixtures thereof. Specific examples of the foregoing materials include ethanol, propanol, isopropanol, butanol, methyl ethyl ketone, methyl isobutyl ketone, acetone, butyl acetate, amyl acetate, ethyl acetate, high solvency petroleum naphtha, gasoline, toluene, xylene, benzene, and other similar hydrocarbons. The following composition is illustrative of a suitable dispersion for roller coating:

	Parts by weight
Ethyl cellulose	2.0
Zinc stearate	22.0
Talc	9.0
Ethyl alcohol	67.0

The talc serves as a filler for the ethyl cellulose resin and is purely optional. When desired, talc or other inert fillers can be employed in quantities as high as 9 parts of filler per part of resin.

After application, the volatile organic liquid is permitted to evaporate and there is left on the abrasive surface a continuous film of the ethyl cellulose having uniformly dispersed and fixed therein small solid particles of zinc stearate and talc. The dispersion is applied in sufficient quantity to provide preferably between about 5 and 25 milligrams of film per square inch of surface area. If desired or necessary, more than one coat of the dispersion can be applied to provide the required quantity of film on the sheet surface.

The following examples are illustrative of the underlying principles of our invention and are not to be construed as unduly limiting thereof:

EXAMPLE I

Coated abrasive articles illustrative of the present invention were prepared as follows:

A rubberized paper backing was used. This backing was prepared by beater-treating a cellulose pulp with an acrylonitrile-butadiene elastomer containing from about 30 to 50 mol percent of acrylonitrile. The latex was precipitated upon the pulp fibers by adjustment of the pH of the beater furnished with alum.

Standard sandpaper making technique was employed in preparing a coated abrasive sheet using the rubberized paper described above. A make coat was deposited upon the backing. This make coat consisted of Grade BB hide glue containing 25% glycerine. The coating adhesive was held at 145° F. in the coating pan through which the applying roll rotated and had a viscosity of 20 Twaddell. The paper was coated with the adhesive at the rate of 150 feet per minute. Immediately following the application of the make coat, 240 grit silicon carbide abrasive grain was applied to the coated sheet by means of an electrostatic field. The grain was applied to give a concentration of .03 g. per square inch. This is a standard weight of grain used to produce an A-weight open-coated sheet of sandpaper.

The make coat of adhesive was dried at a temperature of from 100 to 110° F. for about ten minutes, and then a sized coating layer of adhesive was applied. This adhesive consisted of Grade BB hide glue having a viscosity of 20 Twaddell at 145° F. The product was then dried at a temperature of about 110° F. for two hours, and then rolled into drums.

Portions of the above open-coat silicon carbide A-weight paper were roller coated on the abrasive side with a dispersion containing 67 parts by weight of ethyl alcohol, 22 parts of zinc stearate, 9 parts of talc and 2 parts of dissolved ethyl cellulose, after which they were dried to effect evaporation of the ethyl alcohol. The depth of the coating roll in the dispersion was adjusted to apply varying amounts of the dispersion to separate portions of the paper. After drying, the papers so produced contained 6, 8 and 10 milligrams of dried zinc stearate-ethyl cellulose film per square inch of surface area, respectively.

EXAMPLE II

Tests were performed in which the three products of Example I, designated A, B and C for the 6, 8 and 10 milligrams per square inch of zinc stearate-ethyl cellulose film, respectively, were compared with the corresponding untreated paper and a corresponding product prepared according to the method of British Patent No. 712,718 having about 6 milligrams of loosely held small zinc stearate particles per square inch of surface area. In this comparison test pieces were prepared by spray coating with a green pigmented automotive finish blocks of polymethyl methacrylate having dimensions of 3 inches by 5 inches by ½ inch. The painted plastic blocks were mounted on an oscillating bed. The test specimens of treated and untreated abrasive sheets were mounted on a double pad air-operated oscillating Sundstrand sander. This sander was counterbalanced to obtain a uniform pressure of approximately ½ pound per square inch over the plastic blocks. The tests specimens were in oscillating contact with the painted blocks for a total period of 4 minutes in a cycle of ½ minute on and ½ minute off. The weight of the painted blocks was recorded before sanding and after sanding by means of a chemical balance. The difference in weight representing the amount of stock removed was recorded. The weight of the test specimens was recorded before and after each ½ minute sanding cycle to determine the amount of loading on each sheet after sanding. The results of these tests are recorded in Table I.

Table I

Description	Time in Contact with Workpiece (Min.)	Weight of Lacquer Removed (Grams)	Weight of Loading on Abrasive (Grams)	Remarks
Product of British Patent No. 712,718 having 6 mg./in.² of zinc stearate particles loosely held.	½	.2052	.0907	Loading higher than on products of present invention.
	1	.3342	.1069	
	1½	.4154	.1141	
	2	.4167	.1164	
	2½	.4621	.1185	
	3	.4999	.1093	
	3½	.5254	.1114	
	4	.5554	.1114	
Silicon Carbide A-weight paper—Untreated.	½	.1129	.0570	Loading continues to build up. Low stock removal.
	1	.1962	.0988	
	1½	.2581	.1159	
	2	.2934	.1136	
	2½	.3120	.1175	
	3	.3536	.1239	
	3½	.3695	.1236	
	4	.3952	.1247	
Specimen A (6 mg./in.² of zinc stearate-ethyl cellulose film).	½	.2359	.0905	This coating is somewhat light, although in actual hand sanding it is preferred by some customers. Stock removal is somewhat greater than product of British Patent. Stock removal considerably greater than uncoated sheet. Loading on paper is lower than on product of British Patent. It will last longer than the product of the British patent for this reason.
	1	.3104	.0880	
	1½	.3871	.0960	
	2	.4382	.0925	
	2½	.4878	.0957	
	3	.5149	.0912	
	3½	.5546	.0951	
	4	.5780	.0901	
Specimen B (8 mg./in.²)	½	.2165	.0554	This is the optimum coating weight. Stock removal proceeds at a high rate. After an initial loading, the paper continually "frees" itself and avoids building up. Even at the last interval, .0513 g. were removed. This paper would continue to act for a much longer time.
	1	.3530	.0635	
	1½	.5020	.0705	
	2	.5644	.0645	
	2½	.6310	.0700	
	3	.6827	.0702	
	3½	.7672	.0610	
	4	.8185	.0645	
			(Loss of Zn Stearate)	
Specimen C (10 mg./in.²)	½	.0136	−.0018	This illustrates that under the test conditions for 240 grit, 10 mg./in.² is too heavy. It must be borne in mind, however, that a very light pressure was used in contacting the test piece. Coatings of this weight do perform satisfactorily in actual production.
	1	.0212	−.0050	
	1½	.0245	−.0061	
	2	.0288	−.0129	
	2½	.0301	−.0163	
	3	.0321	−.0181	
	3½	.0354	−.0319	
	4	.0377	−.0398	

EXAMPLE III

In the sanding of the sealer coat on furniture cabinets in a furniture factory using a coated abrasive article prepared according to the method described in British Patent No. 712,718 having a loosely held coating of small solid particles of zinc stearate (approximately 6 mg. per square inch of surface area) and a good size of 240, the operator used three ordinary sheets to sand one cabinet. When using a corresponding product prepared in accordance with the present invention (Specimen A in Example II) the operator was able to sand three cabinets with one sheet before it became useless. This represents a 900% improvement in the useful life of the product of this invention as compared with previous products of a similar nature.

EXAMPLE IV

In the sanding of primer coats on automobile bodies and fenders employing a 240 grade silicon carbide finishing paper having about 6 mg. per square inch of surface area of a film of ethyl cellulose containing small solid particles of zinc stearate dispersed therein, prepared in the manner described in Example I, no blisters or peeling was experienced in the final coat of enamel. A corresponding product prepared in the manner described in British Patent No. 712,718 resulted in several blisters in the final coating requiring additional refinishing.

While this invention has been described and exemplified in terms of its preferred modifications, those skilled in the art will appreciate that changes can be made without departing from the spirit and scope of the invention.

We claim:

1. An improved abrasive article consisting of a flexible base comprising a paper impregnated with a rubber latex, said base having on one side an adherent flexible adhesive with embedded abrasive grains therein, and a coating thereover of a continuous film of a resin selected from the group consisting of cellulose ether resins, polyacrylic ester resins, and vinyl resins having uniformly dispersed therein solid particles of a metallic water-insoluble soap of a saturated fatty acid having from 16 to 18 carbon atoms, said continuous film containing from 1 to 20 parts by weight of metallic soap per part of resin, said abrasive article containing from 1 to 40 milligrams of film containing metallic soap per square inch of surface area.

2. The article of claim 1 in which there is present from 5 to 25 milligrams of film per square inch of surface area.

3. The abrasive article of claim 1 wherein zinc stearate is the metallic water-insoluble soap employed.

4. The abrasive article of claim 1 wherein calcium stearate is the metallic water-insoluble soap employed.

5. An improved abrasive article consisting of a flexible base comprising a paper impregnated with from 4 to 20 weight percent of a butadiene-acrylonitrile copolymer latex, said paper base having on one side an adherent flexible adhesive with embedded abrasive grains therein, and a coating thereover of a continuous film of a resin selected from the group consisting of cellulose ether resins, polyacrylic ester resins, and vinyl resins having uniformly dispersed therein solid particles of zinc stearate, said continuous film containing from 1 to 20 parts by weight of said zinc stearate per part of resin, said abrasive article containing from 1 to 40 milligrams of film containing zinc stearate per square inch of surface area.

6. The abrasive article of claim 5 wherein the continuous film contains ethyl cellulose.

7. An improved abrasive article consisting of a flexible base comprising a paper impregnated with from 4

to 20 weight percent of a butadiene-acrylonitrile copolymer latex, said base having on one side a coating of glycerine modified animal glue containing embedded abrasive grains, and a coating thereover of a continuous film of ethyl cellulose having uniformly dispersed therein small solid particles of zinc stearate, said continuous film containing from 1.2 to 3 parts by weight of said zinc stearate per part of ethyl cellulose, said abrasive article containing from 5 to 25 milligrams of film containing zinc stearate per square inch of surface area.

8. In a process of preparing sheet abrasives wherein a rubber latex impregnated base material is coated with an adherent adhesive having embedded therein abrasive grains, the improvement which comprises applying to the abrasive side of said sheet a continuous film of a resin selected from the group consisting of cellulose ether resins, polyacrylic ester resins, and vinyl resins having uniformly dispersed therein small solid particles of a metallic water-insoluble soap of a saturated fatty acid having from 16 to 18 carbon atoms, said continuous film being applied as a dispersion of solid particles of said metallic soap in a substantially inert volatile liquid containing a dissolved resin, and dried to form said continuous film on the abrasive surface, the dispersion being applied in a quantity sufficient to provide the final abrasive sheet with from 1 to 40 milligrams of film containing metallic water-insoluble soap per square inch of surface area.

9. A process according to claim 8 wherein the metallic water-insoluble soap employed is zinc stearate.

10. In a process of preparing sheet abrasives wherein a rubber latex impregnated base material is coated with an adherent adhesive having embedded therein abrasive grains, the improvement which comprises applying to

the abrasive side of said sheet a continuous film of ethyl cellulose having uniformly dispersed and fixed therein small solid particles of zinc stearate, said continuous film being applied as a dispersion of zinc stearate in a substantially inert volatile liquid containing dissolved ethyl cellulose, and dried to form said continuous film on said abrasive surface, the dispersion being applied in a quantity sufficient to provide the final abrasive product with from 5 to 25 milligrams of film containing zinc stearate per square inch of surface area.

11. An improved abrasive article consisting of a flexible rubber latex impregnated base having on one side an adherent flexible adhesive with embedded abrasive grains therein, and a coating thereover of a continuous film of a resin selected from the group consisting of cellulose ether resins, polyacrylic ester resins, and vinyl resins having uniformly dispersed therein small solid particles of a metallic water-insoluble soap of a saturated fatty acid having from 16 to 18 carbon atoms, said continuous film containing from 1 to 20 parts by weight per part of resin, said abrasive article containing from 1 to 40 milligrams of film containing metallic soap per square inch of surface area.

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