This invention relates to coated abrasive sheet material, i.e., sandpaper, having improved resistance to filling and having prolonged abrading life.

One of the chief difficulties involved in the abrading or polishing of many materials, and particularly of soft materials, is the resulting tendency of the abrasive sheet to become clogged or filled with residues removed from the surface being treated. The difficulty is particularly noticeable in operations such as the sanding of solder filled automobile bodies in refinishing shops, in the sanding of varnished wooden articles, and in the finishing of leather.

Attempts have previously been made to overcome the problem of plugging or filling of coated abrasive surfaces. One such attempt involves spacing of the abrasive grains to provide increased areas between the grains and less opportunity for the residues, i.e., abraded fragments, to become impacted in such areas. The procedure is effective over many conditions of sanding, but has not proven entirely successful where high sanding temperatures are involved, as in the sanding of metals.

Various surface treatments have been suggested which, applied to abrasive sheet material, might be expected to improve the resistance of such sheet material to filling and plugging. These materials are generally of a waxy nature, and are frequently found to produce a waxy residual film on the article being abraded, which film must then be removed by solvent action before further treating the surface.

The present invention provides an abrasive coated sheet material, of the nature of sandpaper, which may have any desired arrangement or concentration of abrasive particles on the surface thereof, and which has high resistance to filling or plugging while still being devoid of any tendency toward imparting residual films to surfaces being abraded or polished. The abrasive articles hereof resist filling even when used in dry abrading operations.

These and other advantages are obtained by applying to the abrasive coated surface of the sandpaper sheet material an extremely minute but still highly effective surface deposit or coating of an organo-silicon compound.

Prior to the present invention, no one, at least so far as we are aware, ever attempted to treat an abrasive coated sandpaper sheet material with an organo-silicon compound, either to improve the resistance of the sheet to filling, or for any other purpose. The lack of such attempt is not surprising in view of the known characteristics of these compounds. They are known to impart adhesive resistant properties to many surfaces, particularly to metal surfaces, even when employed in extremely small amounts, so that the presence of traces of such materials on the surfaces of automobile bodies would be expected to result in poor adhesion of subsequently applied lacquer coatings to such bodies, and to result in rapid failure of the lacquered surface. As an example of this effect, it has been observed that lacquer coatings sprayed over a clean steel surface, which had been coated with as little as 0.001 grain of silicone polymer per square inch of such surface, were almost completely non-adherent to the panel, being easily scraped off by a fingernail. It is also known that silicones, when once applied to clean metal surfaces, are almost impossible to completely remove, either by means of solvents or in any other way. A portion of such silicone coatings, of course, is quite readily removed by rubbing and solvent action; however, there remains on the metal surface a residual highly adherent film which is almost impossible to remove. Hence, it might be expected, based upon experience with other coatings on abrasives, that the application of a coating of an organo-silicon material to the mineral surface of an abrasive sheet or disc would unavoidably result in transfer of at least a portion of such coating to the surface of metal or other articles subsequently to be abraded, with resultant soiling of such metal surfaces and loss of effective bonding of lacquers and similar coatings thereon.

Surprisingly, it has now been found that the organo-silicon compounds may be applied, and also in rather substantial quantities, to the surfaces of sandpaper, abrasive discs, and other surface coated abrasive sheet materials, to provide abrasive products having greatly improved resistance to filling and plugging, having improved cutting and polishing qualities and prolonged life, and which may be employed in the abrading and polishing of metal and other surfaces without in any way decreasing the adhesion of subsequently applied lacquer and other coatings to such metal surfaces.

The following examples illustrate specific but non-limitative embodiments of the invention:

Example 1

An abrasive disc, consisting of grit 36 aluminum oxide abrasive grain bonded to a flexible vulcanized fiber backing with a phenolic resin bond coat and size coating, was treated on the mineral abrasive surface with a solution of an organo-silicon compound.

The organo-silicon compound employed was a dialkylsilanediol, specifically t-butyl-3-chloropropylsilanol. In the refined state it had melted point of about 57° C. and a flash point of about 150° F. A mixture of approximately 5 parts of the silicone compound and 95 parts of an organic solvent, xylol, was brushed over the mineral side of the dried abrasive sheet at a coating weight between about 30 to 35 grains per 4" x 6" area of abrasive sheet. After application of the mixture, which could as easily have been done by dipping, roll coating, etc., the resulting article was air dried at room temperature for about 2 hours to evaporate the solvent. Other volatile temporary solvents for the silicone compound are equally suitable to employ. Drying at a raised temperature below the flash point of the organo-silicon compound is optional and improved results may also be obtained with such a step.

The organo-silicon treated article of this example and an untreated abrasive article otherwise identical to the article hereof were compared performance-wise in a solder sandwich abrading test. Each article in the form of a disc was rotated under constant pressure in contact with the periphery of revolving disc sandwiches comprised of a solder layer between two thin steel discs.
The ratio of the peripheral surface area of steel to the peripheral surface area of solder in contact with each revolving abrasive disc was approximately that of 2 to 3. No solvent, lubricant or coolant was employed during the abrading. After ten minutes, the loss in weight of each solder sandwich was determined. The abrasive disc not treated with a surface deposit of organo-silicon compound removed only 63 grams of solder and steel from the sandwich, while the silicone treated disc removed 97 grams under the same conditions of abrading. This amount to an improvement on the order of 35% in the speed of abrading exhibited by the organo-silicon treated disc. Examination of the mineral surface of the organo-silicon treated disc after the foregoing test revealed that it was substantially free of adherent fillings from the solder sandwich while a like examination of the untreated article revealed that the solder and iron had filled and closed most of the space between abrasive grains and that the very little surface area of the coating of sizing adhesive remained uncovered. The untreated disc, therefore, could not be used satisfactorily in further abrading operations, while the treated disc still would perform abrading satisfactorily.

The treated disc containing only a very small amount of loosely adherent fillings from the solder sandwich was, during abrading, continually partially “filled” in various areas with abraded fragments of the sandwich but that these fragments, being only loosely adherent to the abrasive surface, were continually removed therefrom and thrown off the surface as abrading progressed.

Example 2
An article otherwise identical to Example 1 was made using a different organo-silicon surface deposit, i.e., a mixture of chloro- and methyl-silanes having a plurality of amino silane monomers and a boiling point of about 220°C at a pressure of 10 mm of mercury. A suitable similar composition commercially available is that marketed by the General Electric Company under the name silicon fluid “SF99.” A mixture of approximately 5 parts of the silicon compound, 94.9 parts of xylol, and 0.1 part of a curing agent, zinc octoate, was sprayed over the mineral side of the abrasive sheet at a coating weight of about 30 to 55 grams per 4” x 6” area of abrasive sheet. The article was then raised to about 300°F for 30 minutes to cure, i.e., polymerize, the organo-silicon compound and evaporate the xylol. Cure, however, is optional and improved results may be obtained without such a step. Using the same test as in Example 1, the abrasive disc of this example exhibited a 50% improvement in abrading over the untreated disc. In wood sanding, the improved article of this example exhibited an even greater percent of improvement in speed of abrading, i.e., the amount of stock removed in a set period of time, over an otherwise comparable untreated article.

A further test was conducted using a radioactive organo-silicon treated abrasive article of this invention in the abrading of solder-filled automobile fenders. It is imperative in such an operation that no transfer of the organo-silicon compound to the automobile fender takes place because the fender is lacquered after abrading. In this test also, abrading was accomplished rapidly and no substantial adherent filling upon the abrasive sheet was evident. The radioactive organo-silicon compound employed was impossible to detect even in trace amounts upon the abraded surface. Lacquering of the fender was accomplished without difficulty.

Example 3
Another example of an abrasive article of this invention is that made using a fibrous hemp paper backing support member, an animal hide glue making adhesive, a coating of grit 220 fused aluminum oxide abrasive grain, a dilute animal hide glue sizing adhesive, and a thermosetting organo-silicon resin.

The organo-silicon resin was sprayed on the dried mineral surface of the abrasive structure hereof in a 5% solution (concentration by weight) in xylol with approximately 0.025% part of zinc octoate in the solution for every 100 parts of dissolved resin. The thermosetting resin contained a small proportion of methyl siloxane groups and a plurality of aromatic, including phenol, groups attached to silicon atoms. Such a thermosetting resin is available commercially under the trade designation “Silicone SR-82” by the General Electric Company. The xylol solution of resin was sprayed over the mineral surface of the abrasive structure in the amount of approximately 6 to 8 grams per 4” x 6” area of surface, after which the solvent was allowed to evaporate at room temperature, i.e., the deposit of organo-silicon compound was not heated so as to cure the same. The resin however, was in a slightly polymerized state in solution prior to application, that is, most of the silicon atoms thereof were chemically bonded through oxygen linkages to other silicon atoms in short polysiloxane chains. This treated abrasive article and an identical abrasive article not treated with a silicone were tested in the dry sanding of leather soles for shoes. The treated disc produced twice as many finished pieces as an untreated article otherwise made in accordance with this example. This amounts to a 100% extension of the useful life of the article.

Example 4
The article of this example is particularly effective in abrading plastics (as well as also leather) materials. The article was made using a cotton cloth backing impregnated with starch, animal glue, and inorganic fillers. Upon the backing was layered a layer of animal hide glue making adhesive, a layer of grit 220 silicon carbide mineral abrasive particles, a thin layer of animal hide glue sizing adhesive, and a deposit of an organo-silicon resin. The resin employed was predominantly a highly polymerized dimethyl siloxane polymer. A suitable similar commercially available resin is that sold under the trade designation “Silicone SR-53” by General Electric Company. Five parts of this resin dissolved in 95 parts of xylol was sprayed at a coating weight of 6 to 8 grams per 4” x 6” area of mineral abrasive surface. After application of the resin the composite silicone-treated structure was dried and compared with a like untreated abrasive article in the abrading of a plastic material using a standard test procedure.

The plastic material selected for the abrading test was a substantially (but incompletely) cured phenol formaldehyde resin cast in the shape of a cylinder of one inch diameter. The cylinder was lowered through a guide onto a rotating silicone treated disc made according to this example, a weight placed on the upper end of the cylinder, and abrading continued for 14 minutes. The surface speed of the rotating disc at the center point of abrading contact was approximately 500 surface feet per minute. The same conditions were employed in conducting a plastic abrading test using an untreated disc otherwise made the same as the one of this example. The silicone treated disc removed 37% more plastic material during abrading than the untreated disc. Such an improvement is particularly noteworthy in this art. The untreated disc used in the test was substantially completely filled at the end of 14 minutes and was not suitable for further abrading operations. In contrast, the mineral surface of the treated disc used in the test was sufficiently exposed so as to be suitable for further abrading. A similar test conducted with the improved abrasive article of this example indicated that it exhibited an improvement of approximately 43% over an otherwise comparable untreated disc in the abrading of leather.
Example 5

The article of this example was made using a cotton cloth backing, an animal hide glue making adhesive layer, grit 80 fused aluminum oxide abrasive grain, phenol formaldehyde sizing coat, and a deposit of a predominantly dimethyl siloxane linear polymer. Such a polymer is available from the Dow Corning Corporation under the trade designation "Silcone DC-35A."

A 25% (by weight of polymer) water emulsion of the dimethyl siloxane polymer was sprayed, after substantially drying the abrasive size coating, upon the mineral surface of the abrasive structure using a coating weight of 10 to 15 grains of the water emulsion per 4" x 6" area of mineral surface. After application of the emulsion, the article was heated to drive off the water.

The resulting silicone treated abrasive and an untreated abrasive article otherwise the same as the treated article of this example were each tested for their speed in abrading an oak dowel. Conditions for the tests were analogous to those set forth in Example 4 with respect to plastic abrading with the exception that a two minute abrading time was used for all tests. As a result of several tests, it was found that the treated articles of this example removed on the average of 66% more wood from the oak dowel than the untreated articles in an equal period (2 minutes) of time. Treated articles made according to this example were still suitable to use in further abrading operations after the test period of abrasion. Untreated articles, however, were substantially filled and clogged after two minutes. Here again is shown the great improvement in the life of abrasive articles made according to the teachings hereof. A particular advantage also is that, because the organo-silicon deposit does not transfer to work surfaces being abraded, the adhesion as well as other properties of finishing lacquers on wood (as well as other surfaces) is neither destroyed nor adversely affected during abrading operations.

From the examples hereof, it will be evident that our articles exhibit a particularly improved abrading life in a wide variety of specialized as well as general abrading operations. An increase in abrading life at least greater than 15-20% is exhibited by the improved articles hereof over like articles not treated with an organo-silicon compound.

Preferably organo-silicon compound deposited upon the mineral surface of an abrasive structure will be in a quantity ranging between approximately 0.006 and 1.3 grains per square inch. About 0.05 grain per square inch is preferable to employ. Larger amounts than 1.3 grains per square inch may be used but do not give especially pronounced advantages and are to be avoided from the standpoint of expense.

Various organo-silicon compounds such as alkyl siloxanes, alkoxy siloxanes, aralyl siloxanes, aryl siloxanes, silazanes, etc., as well as others may be applied to abrasives to gain improved results as taught herein. Characteristically, the organo-silicon compounds employable have a carbon to silicon atom ratio of at least 1 to 1 and generally preferably greater than 2 to 1.

We claim:
1. A flexible abrasive article highly resistant to filling by abraded fragments from surfaces being abraded, said article comprising a flexible, organic, backing-support member, a layer of mineral abrasive grain adhesively bonded thereto by an abrasive bond material free of organo-silicon compound, a sizing coat over said layer of mineral abrasive grain, said sizing coat being free of organo-silicon compound, and upon the size-coated mineral side of the foregoing structure a surface deposit consisting of between 0.006 and 1.3 grains per square inch of an organo-silicon compound characterized by being non-transferring to the surface of materials abraded and having a carbon to silicon atom ratio of at least 1 to 1, said article being characterized by an abrading life at least 15-20% longer than a like article without said surface deposit.
2. A flexible abrasive article highly resistant to filling by abraded fragments from surfaces being abraded, said article comprising a flexible, organic, backing-support member a layer of mineral abrasive grain adhesively bonded thereto by an abrasive bond material free of organo-silicon compound, a sizing coat over said layer of mineral abrasive grain, said sizing coat being free of organo-silicon compound, and a surface deposit upon the size-coated mineral side of the foregoing structure, said surface deposit consisting essentially of between 0.006 and 1.3 grains per square inch of an organo-silicon compound characterized by being non-transferring to the surface of materials abraded, said article being characterized by an extended abrading life on the order of more than 15-20 percent longer than a like article without said surface deposit.
3. In a process of preparing an improved fill-resistant flexible abrasive article comprising a flexible, organic, backing-support member, a layer of mineral abrasive grain adhesively bonded thereto by an adhesive bond material free of organo-silicon compound, and a sizing coat free of organo-silicon compound over said mineral abrasive grain, the steps comprising: applying upon the size-coated mineral abrasive side of the abrasive structure sufficient amounts of a mixture of an organo-silicon compound and a volatile temporary vehicle therefor to provide between 0.006 and 1.3 grains of said organo-silicon compound per square inch upon evaporation of said vehicle and (2) evaporating the volatile temporary vehicle from said mixture leaving the organo-silicon compound deposited upon the mineral side of said abrasive structure, thereby to form a fill-resistant, flexible, abrasive article, the deposit upon the surface of which is characterized by being non-transferring to the surface of materials abraded using said article.
4. In a process of preparing an improved fill-resistant flexible, organic, abrasive article comprising a flexible backing-support member, a layer of mineral abrasive grain adhesively bonded thereto by an abrasive bond material free of organo-silicon compound, and a sizing coat over said layer of mineral abrasive grain, said sizing coat being free of organo-silicon compound, the steps comprising (1) applying upon the mineral abrasive side of the abrasive structure sufficient amounts of a mixture of an organo-silicon compound and a volatile temporary vehicle therefor to provide between 0.006 and 1.3 grains of said organo-silicon compound per square inch upon evaporation of said vehicle and (2) heating the mixture to evaporate the volatile temporary vehicle and leave the organo-silicon compound deposited upon the mineral side of said abrasive structure, thereby to form a fill-resistant, flexible, abrasive article, the deposit upon the surface of which is characterized by being non-transferring to the surface of materials abraded using said article.
5. A flexible abrasive article highly resistant to filling by abraded fragments from surfaces being abraded, said article comprising a flexible, organic, backing-support member, a layer of mineral abrasive grain adhesively bonded thereto by an abrasive bond material free of organo-silicon compound, a sizing coat over said layer of mineral abrasive grain, said sizing coat being free of organo-silicon compound, and a surface deposit upon the size-coated mineral side of the foregoing structure, said surface deposit consisting essentially of between 0.006 and 1.3 grains per square inch of a dialkoxysiloxanosilane.
6. A flexible abrasive article highly resistant to filling by abraded fragments from surfaces being abraded, said article comprising a sheet abrasive base structure characterized by a tendency to gradually fill after a period of use in abrading operations and thereby to become
clogged with abraded fragments, said base structure including a flexible sheet-backing member and a layer of abrasive grain adhesively bonded thereto by an abrasive bond coating and an abrasive size coating, said bond and size coatings each being free of organo-silicon compound, said size coating being over said abrasive grain, and a surface deposit upon the size-coated mineral side of the foregoing base structure, said surface deposit consisting essentially of an organo-silicon compound characterized by being non-transferring to the surface of materials abraded.

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