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PROCESS OF PUMICING A SURFACE

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ABSTRACT OF THE DISCLOSURE

This application relates to a pumicing composition having abradant and solid lubricant particles dispersed throughout a volatile organic solvent, the lubricant particles being substantially insoluble in the organic solvent and the organic solvent being substantially chemically non-reactive with the abradant particles and the lubricant particles. In use, the pumicing composition is repeatedly moved back and forth over the surface to be cleaned as the proportion of the organic solvent in the pumicing composition is substantially reduced to zero.

This invention relates to a pumicing composition for glass, metal, plastic, semiconductor and insulator surfaces. More particularly, the invention relates to a composition to be used in the pumicing and cleaning of the surface of a body whose surface electrical conductivity must be maintained as low as possible because of the use to which the surface will be applied. In particular, the compositions herein disclosed have operability in the pumicing and cleaning of the surface of a repeatedly used xerographic photosensitive member.

In general, when the surface of a glass, metal, plastic semiconductor or insulator member is contaminated with moisture, oil, grease, various gases, etc., there will occur a modification of the chemical and/or physical properties of such surfaces, generally resulting in a deterioration of the electrical, optical, and mechanical properties thereof. It is highly desirable to have a pumicing and cleaning composition which can adequately remove such contaminants thereby substantially restoring the deteriorated surface to its initial physical properties. Though the following description will disclose the application of such a pumicing and cleaning composition to a xerographic photosensitive member, it should be understood that this is merely an exemplary surface and that the composition herein disclosed is equally applicable to the restoration of the physical properties of the various surfaces hereinabove mentioned.

In the art of xerography, as is well known, an electrostatic latent image is produced on the surface of a photoconductive insulating material. This frequently is accomplished by first producing on the photoconductive insulating surface a substantially uniform electrostatic charge, for example, by exposure to a corona discharge device, and then exposing to a light image. Upon such exposure, the uniform electrostatic charge is dissipated in the areas which are subjected to this exposure leaving a latent electrostatic image in the areas which have not been so exposed. Visible images are then produced on the photoconductive insulating member surface by the electrostatic attraction of finely divided developed particles to the charged (i.e., non-exposed) areas. When the photoconductive insulating material is to be reused, the developer particle images are transferred to a suitable substrate, for example, a sheet of paper, and then the photoconductive insulating material surface is cleaned to prepare it for the next copying process. Various kinds of photoconductive insulating members have been disclosed, including vitreous selenium, and zinc oxide powder dispersed in a binder material. The former is reused by transferring the finely divided developer powder image to another substrate, while the latter is not reused as the developer particle images are fixed directly on the photoconductive insulating layer. The cleaning composition herein disclosed is suitable for cleaning the surface of a reusable photoconductive insulating material, as represented by the vitreous selenium layer.

For simplicity, the xerographic recording element comprising the substrate coated with the photoconductive insulating layer will be called the "xerographic photosensitive member." Additionally, the cleaning and pumicing composition will be called the "pumicing" composition and the cleaning and pumicing of the surface of the xerographic photosensitive member will be called "pumicing." It should be noted that a xerographic photosensitive layer employing vitreous selenium as the photoconductive insulating material is considered representative of reusable xerographic photosensitive members and that the pumicing material herein disclosed can be applied equally well to other reusable xerographic photosensitive members.

When a reusable xerographic photosensitive member is repeatedly used, cleaning of the finely divided developer particles (i.e., the electrically charged thermoplastic resin powder) from the surface of the member is generally not complete, so that after an extensive period of use, a thin resinous film forms on the photoconductive insulating surface. This gives rise to surface contamination by itself and along with other substances so as to reduce the desirable physical characteristics of the photosensitive member. In the case of a selenium photosensitive member which employs vitreous selenium in the super-cooled state, even a small amount of hydroscopic material sticking to the photosensitive surface will accelerate the crystallization of the selenium with the resultant deterioration of the physical properties. Deterioration is also promoted by the surface being contacted with acid or alkali fumes. It has also been found that the corona discharge which is used to provide the initial electric charge on the surface of the photosensitive member accelerates the crystallization of the selenium surface as does continuous exposure to light. Further use of a contaminated xerographic photosensitive member prevents the production of good quality copies.

Almost all of the deteriorations which produce degeneration of the copy image quality occur at the top surface of the photosensitive member. Therefore, the deteriorated photosensitive member can be restored to its initial physical properties, which are capable of producing good quality copy images, by pumicing the deteriorated layer on the top surface of the photosensitive member so that the contaminating material is effectively removed from the photosensitive member. This may take the form of removing deposits which have built up on the photoconductive insulating surface and/or removing the contaminated portion of the surface layer itself.

Accordingly, it is an object of this invention to provide a pumicing material which is capable of substantially renewing the deteriorated surface of a treated member.

It is an object of this invention to provide a pumicing material which is capable of substantially restoring the initial physical properties of a reusable xerographic photosensitive member.

An additional object of this invention is to provide an improved pumicing material which can be used for removing surface contamination from a photosensitive member thereby substantially restoring the member's initial physical properties.

A further object is to provide a pumicing material suitable for finishing the deteriorated surface of the sensitive member to a mirror-like finish.

A further object is to provide an improved pumicing material which will not chemically deteriorate the photosensitive member during and after pumicing.

It is a further object of this invention to provide an improved method for the pumicing of contaminated surfaces.

Further objects will become apparent to those skilled in the art as the disclosure is more fully made.

The above and further objects may be accomplished in accordance with the present invention by pumicing the contaminated surface with a composition comprising abrading powder particles and solid lubricant particles dispersed in volatile liquid medium. Suitable abradants include Alundum; silicon carbide and fused alumina, such as the material commercially available under the trademark Carborundum from The Carborundum Co. of Niagara Falls, N.Y.; garnet; corundum; emery; iron oxide; chrome oxide; lime, alumina powder; silica; calcium carbonate; diatomaceous earths, such as the product available under the trademark Celite from Johns-Manville Co. of New York; and cerium oxide powder. For purposes of this invention, it is preferred that the abradant have a particle size less than about 1.5 micron and that the particles are as uniformly spherical as possible. Such a preferred abradant gives good results in that it pumices the deteriorated surface to a mirror-like finish. However, since the abrading power of an abradant having a particle size less than 1.5 micron is less than that of a larger size abradant, the abrading power can be increased by dispering the powder in a volatile, chemically stable liquid.

The liquid dispersion medium should be sufficiently volatile so as not to leave a residue on the cleaned surface. Additionally, the liquid should be chemically stable so that it will not decompose during extended periods of storage. It is also desirable that the liquid be chemically inactive in that it should not react with the adjuvants added thereto nor with the surface to be treated. To insure the proper restoration of the electrical surface insulating properties of the treated member, the electrical resistivity of the liquid should be greater than 10^{10} ohms-cm. Suitable liquids include ligroin, isopropyl alcohol, trichloroethylene, solvent naphtha, etc., and other organic solvents which are immiscible or substantially immiscible with water.

Further, it has been found that the addition of a solid lubricant to the pumicing composition will also increase the power of the compositions to produce a mirror-like finish in the pumicing process. It is preferable to use a solid lubricant which is insoluble in the volatile liquid dispersion medium. Examples of such solid lubricants include metal stearates, such as zinc stearate; graphite; talcum, etc.

When a surface of a xerographic photosensitive member is to be pumiced, it is desirable that the pumicing composition have the following properties or produce the following results: During and after pumicing no deleterious chemical reaction between the components of the pumicing material and the photosensitive member should occur; (2) no residue or stain should be left on the pumiced surface, or, if a thin film is formed on the pumiced surface, it should be stable and chemically inactive to the photosensitive member and should have properties similar to the underlying photoconductive material; (3) the pumiced surface should have a mirror-like finish; and (4) the electrical conductivity of the pumiced photosensitive surface should be maintained at approximately the same order of magnitude as that of the insulator. The pumicing composition heretofore disclosed has been developed to bring about these desirable results in an uncomplicated manner.

With specific reference to a xerographic photosensitive member comprising an insulating photoconductive layer of vitreous selenium, it is preferred to use an abradant having high pumicing ability because of the extreme hardness of the photoconductive material. The abradants heretofore mentioned have been used satisfactorily for pumicing a photoconductive layer to a mirror-like finish.

While the abrading power of the pumicing material which contains the abrading powder particles dispersed in a liquid is satisfactory, a suitable mirror-like surface finish will not be obtained if the abrading power of the pumicing material remains constant throughout the pumicing process. Therefore, the abrading power of the composition should be gradually reduced as the pumicing method is carried out. It has been found that dry pumicing more easily produces a mirror-like finish than wet pumicing (i.e., where the abradant particles are dispersed in a liquid medium), but by employing a volatile liquid as the dispersion medium, which serves to change the pumicing process from a wet treatment to a dry treatment as the liquid volatilizes, the advantages of both the dry and wet treatment are combined into a single process and the most satisfactory results are obtained.

The following examples are given to enable those skilled in the art to more clearly understand and practice the invention. They should not be considered as a limitation upon the scope of the invention, but merely as being illustrative thereof.

EXAMPLES

The degree and manner of surface finishing a vitreous selenium photosensitive layer polished with various kinds of pumicing materials is set forth below. All of the following examples are conducted in accordance with this procedure. The only differences in the various examples are the nature of the pumicing composition and the composition of the photoconductive surface to which the pumicing composition is applied.

The abradant particles are dispersed in ligroin as the volatile liquid. Absorbant cotton impregnated with the noted composition is moved to and fro in contact with the selenium photosensitive layer under a constant pressure and at a constant speed for a predetermined period of time. Particle size and shape of the abradant material is observed with an electron microscope. The luster of the finished surface is measured with a Model GM–3 gloss meter manufactured by Murakami Shikisai Gijutsu Kenkyu-jo.

TABLE I

Ex.	Abrading powder	Particle size (μ)	Shape	Gloss of polished surface, percent
1	Fresh Se surface			86.7
2	Deteriorated Se surface.			25
3	Cerium oxide	0.3	Sphere, uniform size.	70.7
4	Zirconium oxide	1.1		68.4
5	Calcium carbonate powder.	4.1	Nearly spherical	65.7
6	Bentonite	2.2	Irregular in size and shape.	60.8
7	Acid clay	1.9	do	60.4
8	Rockcite	6.5	Irregular	43.1
9	Celite	5.0	Much irregular	50.3
10	Chrom oxide	8.0		41.2

The following examples illustrate the efficacy of a solid lubricant in combination with the abradant particles dispersed in the volatile liquid. 8.75 grams zinc stearate and the noted amount of cerium oxide particles are dispersed in 29 grams of ligroin. The gloss of the fresh selenium surface is, once again, 86.7% and the gloss of the deteriorated selenium surface is 25%. The pumicing and the gloss-measuring are conducted in the same manner as given in Example I.

TABLE II

Example	Cerium oxide (grams)	Gloss of the polished surface, percent
11	5	68
12	15	79
13	25	78
14	35	75
15	45	72

In a xerographic photosensitive member, deterioration of the phtotoconductive layer reduces the electrostatic charge bearing ability of that layer and makes it impossible to produce good quality copy images. This is thought to be caused by the apparent reduction of the electrical insulating properties in and around the deteriorated portion thereby resulting in a decrease in the lateral electrical resistivity. In such a condition, it is believed that charge carriers can be easily injected into the internal layer of the deteriorated area resulting in a decrease of the ability of the surface to retain an electrostatic charge. A pumicing material should be capable of removing this deficiency thereby substantially restoring the charge bearing ability of the photoconductive layer. One of the values indicating the charge bearing ability is the surface potential of the photosensitive member after a certain period of time has elapsed after the photosensitive member was charged by a corona discharge device. The improvement of this xerographic characteristic of a selenium photosensitive layer when the deteriorated surface is pumiced with the composition of Example 13 is given below in Example 16. Example 16 shows the results of measuring the surface potential of the photosensitive member before and after polishing.

TABLE III.—EXAMPLE 16

State	(A) Surface potential immediately after charging (volts)	(B) Surface potential five minutes after charging (volts)	(A)-(B) (volts)
Before polishing	320	76	244
After polishing	940	414	526

While the invention has been described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the true scope and spirit of the invention.

It should be understood that the present invention is not dependent upon the exact nature of the xerographic photosensitive member employed. As previously noted, the selenium xerographic photosensitive member is considered to be exemplary of the surfaces which can be pumiced by the composition heretofore set forth. The composition of this invention may be used for other reusable xerographic photosensitive members and for other bodies whose surface may be polished to a mirror-like finish and/or whose electrical surface resistivity is maintained at a high insulating level.

Further, as will be apparent to those skilled in the art, additional operations may be performed to achieve the herein disclosed results. Or, in certain circumstances, certain operations may be deleted. The compositions herein disclosed may be modified in numerous ways to, once again, achieve the effective pumicing of the treated surface. All such additions, deletions, modifications, etc., are considered to be within the essential teachings of the inventions.

What is claimed is:

1. The method of pumicing the surface of a member to be cleaned comprising contacting the surface of said member with a pumicing composition comprising abradant particles and solid lubricant particles dispersed in a volatile organic solvent; said organic solvent being substantially chemically non-reactive with said surface, said abradant and said lubricant particles; causing said pumicing composition to be repeatedly moved back and forth over said surface; and gradually reducing the proportion of said organic solvent in said pumicing composition substantially to zero.

2. The method of claim 1 wherein said member is a reusable xerographic photosensitive member.

3. The method of pumicing the surface of a member to be cleaned comprising rubbing the surface of said member with a pumicing composition comprising abradant particles and solid lubricant particles dispersed in a volatile organic solvent; said organic solvent being substantially non-reactive with said surface, said abradant particles and said lubricant particles; simultaneously causing the proportion of said volatile organic solvent in said pumicing composition to be gradually reduced substantially to zero.

4. The method of claim 2 wherein the surface of said reusable xerographic photosensitive member comprises vitreous selenium.

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