POWDER COATED WITH AN ANTI-STATIC AGENT
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ABSTRACT OF THE DISCLOSURE
A micro-starch carrier powder encapsulated with an anti-static agent selected from fatty acid amides, poly-alkylene oxides and tertiary amines, the anti-static agent constituting about 3—5 percent by weight of the total anti-static composition.

This invention relates to anti-static compositions. More particularly, this invention relates to an anti-static composition of the type that may be efficiently applied at any time, and in any amount, to the surfaces of polymer films after their manufacture.

Polymer films that are widely used in, for example, the packaging industry have the unique characteristic of accumulating and developing electrostatic charges during their manufacture which make them relatively difficult to handle either by hand or by known types of processing machinery. This disadvantage causes difficult problems in the separation of, for example, a sheet from a stack of sheets, due to the unsatisfactory slipping and blocking characteristics of the film that have been caused by the electrostatic charges thereon. Thus, to facilitate handling of such polymer films, they are generally supplied with an anti-static, an anti-block or a slip agent that reduces the tendency of the sheets to cling together.

The electrostatic charge problem has been approached in a number of ways. For example, there are many known slip and anti-block agents with which a film or sheet may be coated to increase their partiality, that is, the ease with which they may be separated one from the other when in a stacked or superimposed position. By reducing each individual sheet's resistance to blocking and by increasing its ability for slipping, the sheets are easier to part when being separated either by automatic processing machinery or by hand. However, the function of the slip and anti-block agents is merely to increase the partiality of the film sheets by providing a physically slippery surface or sliding plane between the sheets, as they do not generally prevent the accumulation or build up of electrostatic charges on the sheet. As the terms are used in the industry, blocking normally refers to the resistance encountered when attempting to separate, in a vertical plane, a sheet from a stack of polymer film sheets; and resistance to slipping normally refers to the resistance encountered when attempting to separate, in a horizontal plane, a sheet from a stack of polymer film sheets. Of course, the classic example of an anti-block or slip agent is talc which has been used for many years to decrease the undesirable parting characteristics of all types of polymer film sheets when in a stacked position. However, typical, like most known slip and anti-block agents, tends to change at great trouble to the surface of a clear polymer film, thereby impairing its appearance and clarity.

Another way to eliminate the electrostatic charge problem from polymer film sheets is to add an anti-static agent to the film. The anti-static agent actually prevents the initial accumulation and build up of electrostatic charges on the film, thereby making sheets of the film easier to separate. Anti-static agents may be used in conjunction with the film or sheet materials in a number of ways. For example, the anti-static agent may be either placed into solution or made into an emulsion, with the subsequent solution or emulsion being coated onto the polymer film in liquid form by known means. The liquid medium is then volatilized to evaporate the liquid carrier with the result that the anti-static agent is deposited or coated onto the polymer film. However, this method is costly and gives rise to operational safety problems. Another method frequently used is to incorporate the anti-static agent into the polymer mix prior to the formation of the film, e.g., prior to extrusion of the film. After the film is formed, the anti-static agent will exude to the surface of the film. Of course, one of the primary requirements is that the anti-static agent must exude to the surface of the film in sufficient amount so that it may carry out its function of preventing the accumulation and formation of electrostatic charges. To accomplish this objective, generally more anti-static agent must be added than is actually required to achieve the desired end result, as not all the anti-static agent can be expected to exude to the surface of the film. In addition, it has been found to be quite difficult to control the exudation and, in fact, to find anti-static agents that will act as desired.

While the above methods have been used successfully in the past they do have a number of drawbacks, some of which have already been mentioned. For example, none of the methods is particularly adaptable to quick changes in anti-static agent concentration on or in the polymer film where such is desired to suit different customer preferences. In addition, because of the very nature of the methods employed to incorporate the anti-static agents with the polymer film the problem of waste arises through use of more of the anti-static agent than is actually required to effect the desired result.

The present invention is based on the concept of supporting an anti-static agent on a carrier powder, as by encapsulating the carrier powder in the anti-static agent, whereby the anti-static agent may be easily and precisely metered onto the polymer film. Not only does the encapsulation of the carrier powder by the anti-static agent admit of the precise and convenient handling of the agent, but the effective surface area per unit weight of the anti-static agent is greatly increased.

The inventive concept of this invention has numerous advantages over the prior art. For example, the anti-static composition is much easier to use and little waste is encountered with its use. Once the carrier powder has been encapsulated by the anti-static agent, it may be applied to the polymer film or sheet in a dust or powder mist form. The dust or powder mist may be quite precisely controlled, e.g., by electrostatic metering, in that the deposition rate of the anti-static composition onto the polymer film may be metered to a high degree. Such a method of application eliminates the safety problems and complex equipment necessary when coating the film by solution or emulsion methods, and eliminates the chemical problems of the exudation method. In instances where the amount of the anti-static agent to be added to the sheet varies, due to consumer needs, the concentration or deposition onto the polymer sheet may be easily altered when it is applied in the preferred dust or powder mist form. That is, neither solution nor emulsion concentrations need be changed at great trouble, and anti-static composition of the invention also provides a much greater flexibility of use in that its application to the film may come at any point during the processing of the film, e.g., the composition need not be coated onto the film at the point of manufacture but may be coated onto the film by the user to suit his end product needs.

In addition, we have found that substantially less of the anti-static agent encapsulated carrier powder, as op-
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posed to the anti-static agent by itself, is required to cause a suitable reduction in the accumulation and formation of electrostatic charges on the polymer films. That is, the effective surface area per unit weight of the anti-static agent is greatly increased when used according to this invention, thereby enabling the anti-static agent to be used in accomplishing the desired results.

While this invention will be described and exemplified primarily with respect to polyolefin films, films formed from other materials which have inherent electrostatic charge problems are also intended to be within the inventive concept. For example, other prone materials are: vinyl polymers, e.g., polyvinyl chloride and polyvinyl acetate; cellulose esters, e.g., cellulose acetate, cellulose formate, cellulose butyrate, and cellulose propionate; and cellulose ethers, e.g., ethyl cellulose, methyl cellulose and benzyl cellulose; and polyamides, polycarbonates, polyesters, and regenerated cellulose.

The carrier powder, which is encapsulated by the anti-static agent, must be a morphologically stable and inert powder material. By morphologically stable, we mean that type of powder material which, at ambient or a little above ambient temperatures, will not change its physical form. The carrier powder may be substantially any morphologically stable material, organic or inorganic, that will remain in powder form when the anti-static agent is encapsulated around it. Finely divided powders, i.e., small particle size powders, of the type generally used as anti-block and slip agents in the manufacture of film are preferred. Some typical examples of suitable carrier powder materials are: cellulose material such as cellulose esters, cellulose ethers, regenerated cellulose, cotton linters, wood pulp, micro-starches, and other natural forms; inorganic compounds such as titanium dioxide, calcium carbonate, barium carbonate, and aluminum silicate; naturally occurring inorganic complexes such as diatomaceous earths; and synthetic silicas. The preferred carrier powders for use with polyolefin films are micro-starches such as micro-corn starch and micro-rice starch.

The average particles size of the carrier powder may be anywhere within the range of 30 micromicrons to 100 microns or greater. The primary criterion that governs the particle size is the degree of clarity required in the end product polymer film. For example, if a clear film or sheet must be coated with the anti-static composition, the carrier powder must be essentially white or neutral in color with a preferred particle size of 5 to 20 microns. Particle sizes above about 30 microns start to become visible and, although they are useful for some purposes, would be commercially desirable for clear films. Of course, the powder material may be colored black. However, colored carrier powders would most probably be commercially acceptable for use only where opacity or translucency, or color of the finished film or sheet was no problem.

The anti-static agents may be selected from any group of organic compounds or mixtures which exhibit the characteristic of preventing or reducing the accumulation or formation of electrostatic charges on polymer films. The primary criterion for the anti-static agent is that it have a relatively low melting point, for example, a wax like consistency, so that it may easily encapsulate the carrier powder. Preferred anti-static agents for use with polyolefin films are: tertiary amines, e.g., cetyl amine N,N,N'-di-ethanol, N,N'-di-ethyl amine N,N'-di-ethanol; polyalkylene oxides, e.g., alkyl phenol-ethylen oxide condensate; and fatty acid amides, e.g., N-hexadecyl 1,3 propylene di-amine dipalmitate, oleic acid amide, behenic acid amide, erucyl acid amide, stearic acid amide, and ethylene di-stearamide.

As was mentioned earlier, and in accordance with the principles of this invention, the carrier powder is encapsulated by the anti-static agent. The encapsulation of the carrier powder may be accomplished by any of at least three different methods. The first method includes forming a solution of the anti-static agent and thereafter slurring or uniformly mixing the inert powder into the solution. Typical solvents for the preferred anti-static agents of this invention are organic polar solvents, e.g., acetones, ketones or an alcohol. After the slurry has been uniformly mixed the solvent is permitted to evaporate, leaving as a residue the carrier powder encapsulated by the anti-static agent. The second method includes emulsifying the anti-static agent in a liquid medium, such as water. The carrier powder is then uniformly mixed into the emulsion. The water or liquid medium of the emulsion is subsequently permitted to evaporate, again leaving as a residue the anti-static agent encapsulated carrier powder. Evaporation may be hastened by the addition of heat if desired. The third method by which the anti-static agent may be encapsulated about the carrier powder is by physically milling or mixing the powder and the agent together. The anti-static agents used should have a relatively low melting point, that is, be wax like, so that they may easily and readily encapsulate the carrier powder material. If a high melting point anti-static agent is used, heat must be present in the emulsion or physical mixing apparatus to help the agent flow so that it can encapsulate the carrier powder.

The most practical and optimum concentration of the anti-static agent encapsulation coat on the carrier powder for polyolefin films has been found to be approximately 3 percent by weight of the carrier powder, though higher concentrations of up to 5 percent and higher may be used if desired. The particle size range of the anti-static agent encapsulated carrier powder, i.e., the anti-static composition, is substantially the same as the particle size range of the carrier powder itself because of the small amount of anti-static agent necessary for encapsulation.

There are a number of methods that may be used to apply the novel anti-static composition to the polymer film. Such methods include dry spraying, water suspension spraying, electrostatic metering, or mechanical dusting. Substantially any method or device may be used that will meter the anti-static composition onto the film with the requisite degree of uniformity. The amount of the anti-static composition applied to the surface of the film is governed by the end use of the film, e.g., how great an electrostatic charge resistance is desired and visual quality desired of the film. This will generally be not greater than .2 or .3 percent based on the weight of the sheet if a clear film is desired, i.e., to keep the sheet from turning opaque or translucent, and for general uses will be in the area of approximately .1 percent.

The preferred mode of coating a polyolefin film is by means of an electrostatic metering device because of its ease, convenience and preciseness in depositing the desired amount of the anti-static composition on the film. The preferred anti-static agents of this invention, if coated onto the polyolefin film alone, could not be coated with the rapid, accurate and simple electrostatic metering deposition apparatus as the apparatus would tend to melt the anti-static agents and would not deposit them in dust mist form on the film webs.

Typical electrostatic metering apparatus, of the type preferred for use with this invention, is shown in the accompanying figure. The electrostatic metering apparatus includes a material hopper 10 for retaining the anti-static composition 11 of this invention. The sides 12 of the hopper 10 slant inwardly toward the bottom 13 of the hopper 10 and cooperate with a metering roll 13 in forming the base or bottom of the hopper 10. The clearance between the periphery of the metering roll 13 and the bottom tips 14 of the hopper sides 12 is such that as the roll rotates it carries a coat of the anti-static composition on its surface. An adjustable doctor or scraper blade 15 is provided to enable the thickness of the coating on the metering roll 13 to be varied.
A corona discharge tube 16 is provided below and to the side of the metering roll 13. The corona tube 16 is directed to the surface of the roll 13 so that the particles of the anti-static composition coating on the roll surface are blasted off the roll as it rotates, thereby causing a dust mist 17 that may be closely regulated in density. Hence, the deposition of the anti-static composition on a polymer film web 18 passing beneath the metering roll 13 may be precisely regulated.

The invention is illustrated by the following example in which all percentages are expressed in percent by weight.

**Example**

An isopropyl alcohol solution containing 3% of N-hexadecyl 1,3 propylene diamine dipalmitate (Armour PE-200, Armour Industrial Chemicals Co.) i.e., an alkyl amine acetic acid salt, was placed in a container and 300 grams of a micro-corn starch (Oxy-Dry #5922, Oxy-Dry Sprayer Corp.) was added to the solution. The slurry thus formed was vigorously stirred in the container for approximately 20 minutes. During the period of stirring, the slurry changed to a paste-like consistency. After the 20 minutes expired, the paste was emptied into a flat bottom pan and exposed to the atmosphere for approximately 24 hours. At the end of the 24 hour period, the anti-static composition was substantially dry and was charged into an electrostatic metering sprayer. The dried anti-static composition was metered onto a polypropylene film web having a thickness of 1.0 mil by the electrostatic sprayer at ambient temperature as the web was conveyed beneath the spraying device.

Subsequent to the metering of the anti-static composition onto the polypropylene film, shirt bags were formed from the coated film and stacked in bundles. The bundles were then placed on a table and the bags were removed from the stack one by one. There was no observation of sticking of the anti-static composition coated bags one to the other, i.e., they were readily removed one at a time from the pile. Conversely, when shirt bags made from polypropylene film not having the anti-stick composition of this invention incorporated on their surfaces were removed from a pile or bundle, they clung together in groups of three or four such that it was impossible to pick up one bag at a time without wasted time and effort in separating the top bag from bags underneath. In addition, the polypropylene film so coated substantially resisted the accumulation and formation of electrostatic charges even when processed on metal rollers of automatic processing machinery in areas where the atmospheric relative humidity was less than 50%.

While this invention has been described in relation to films and sheets, it can nonetheless also be used to advantage on items of commerce other than films and sheets such as, for example, synthetic polymer fibers, fabrics, filaments and coatings.

Having described above the preferred embodiment of our invention, what we desire to claim and protect by Letters Patent is:

1. An anti-static composition especially adapted to be coated onto polymeric films to reduce the buildup of electrostatic charges thereon comprising, a micro-starch carrier powder and an anti-static agent encapsulating said carrier powder, said anti-static agent being selected from fatty acid amides, polyalkylene oxides and tertiary amines, said anti-static agent constituting not more than five percent by weight of the total anti-static composition.

2. Composition of claim 1, wherein said anti-static agent is N-hexadecyl 1,3 propylene diamine dipalmitate.

3. Composition of claim 1, wherein said anti-static agent is oleic acid amide.

4. Composition of claim 1, wherein said anti-static agent is ethylene distearamide.

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