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PHOSPHOR CONTAINING PLASTIC POLYSTYRENE

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ABSTRACT OF THE DISCLOSURE

A moldable plastic product comprising polystyrene or copolymers of polystyrene such as the vinyls including, for example, vinyl chloride, vinyl acetate, vinyl butyral, vinylidene chloride, acrylonitrile, butadiene, alpha or beta-methyl styrene and maleic anhydride, and others, at least 45 percent by weight polystyrene of a phthalate plasticizer such as the alkyl, aryl, alkyl aryl, dialkyl and diaryl phthalates and in particular the dioctyl phthalates, at least 3 percent by weight polystyrene or any wax such as natural or synthetic animal, vegetable or mineral waxes; preferred are the paraffin waxes containing paraffinic hydrocarbons having a carbon content of at least 16 carbon atoms, and at least .001 percent by weight polystyrene of an electroluminescent, fluorescent or phosphorescent phosphor such as the P_1–P_{30} type phosphors which include the sulfide and oxide phosphors.

The present invention relates generally to a moldable plastic polystyrene. More particularly, the present invention relates to a useful amusement product of polystyrene which can be molded shaped and has adhesive properties and can be made to glow in the dark.

Amusement devices have been known in the past which include moldable clay, plastic type putty which may be molded and shaped into various forms or extruded into unusual designs in accordance with an exchangeable extrusion plate. Other plastic moldable compositions have been known to have elastic and resilient properties, many of which have met with gerat commercial success in the amusement device and toy manufacturing industry.

It is well known that the toys and amusement devices form a part of an industry that is highly competitive. The art reflecting this competition is constantly striving for new products which may attract the eye of the purchaser and provide entertainment for not only chlidren but also adults. Toys and amusement devices which have been found to have met with considerable success in the past are those that provide changeable visible effects. Included in this group are for instance the motor operated toys. Another class that has been found to be particularly attractive to the public are toys of the lighted or illuminated type which, in the dark, provide unusual visual effects.

Until the present invention, it has not been known to incorporate visual effects in the dark in a moldable plastic material. Moreover, in the toy and amusement field it is necessary to also provide maximum safety precautions against physical hazards. Thus, for a successful commercial toy or amusement device it is important to provide for the safe use of the toy.

Accordingly, it is the principal object of the present invention to provide a moldable plastic product which provides visual effects in a darkened environment.

Another object of the present invention is the provision of an amusement device which is moldable and plastic and which can be safely handled by anyone.

A further object of the present invention is the provision of a moldable plastic product which may be charged

by actinic light rays and be made to glow in the dark.

Another object of the present invention is to provide a moldable plastic product which can be severed, perforated and shaped and retain a uniform glow in a darkened environment.

The present invention is a discovery that the properties and characteristics of polystyrene and also various copolymers of polystyrene can be greatly changed with the addition of a large amount of a phthalate plasticizer, additional desirable characteristics can be obtained by the incorporation of a wax such as a paraffin wax or any animal, vegetable or mineral including the natural or synthetic waxes, and finally this modified polystyrene is capable of receiving phosphors intimately mixed in the product so as to permit the plastic product containing the phosphors to be molded into shapes, severed, or sculptured and at the same time glow in reduced light upon receiving excitation by actinic light rays.

The polystyrene used in accordance with the present invention may be used alone or as a copolymer with a number of the monomers that will copolymerize with styrene. Among such monomers are the vinyls including vinyl chloride, vinyl acetate, vinyl butyral, vinylidene chloride, acrylonitrile, butadiene, alpha or beta-methyl styrene, maleic anhydride, and other vinyl monomers well known to be compatible for copolymerization with polystyrene.

It has been found that the amount of copolymerization, if any, is not critical or necessary, but that the desirable qualities of the present invention are more noticeable when the styrene monomer represents at least 85 percent by weight of the copolymer.

While it has been known in the past to plasticize polystyrene, the amounts of such plasticizer have been relatively small. In the present invention it has been found that at least 45 percent by weight of the polystyrene alone should be a phthalate plasticizer. Among the esters of phthalic acid that may be utilized are the alkyl, aryl, alkyl aryl, dialkyl and diaryl phthalates. Within this broad classification may be listed the following: dimethyl phthalate, diethyl phthalate, dibutyl phthalate, di-isobutyl phthalate, dihexyl phthalate (n or iso), dimethylisobutylcarbinyl phthalate, butyl octyl phthalate, butyl isodecyl phthalate (decyl butyl phthalate), butyl iso-hexyl phthalate, dioctyl phthalate, di-n-octyl phthalate, dioctyl isophthalate, di-isooctyl phthalate, di-isooctyl isophthalate, dicapryl phthalate, di-(2-ethylhexyl) phthalate, dinonyl phthalate, n-octyl-n-decyl phthalate, N-decyl/N-octyl phthalate (phthalate of mixed N-alcohols), octyl decyl phthalate (isooctyl isodecyl phthalate) (isooctyl decyl phthalate), di-decyl phthalate (di-isodecyl phthalate), decyltridecyl phthalate, ditridecyl phthalate, octyl fatty phthalic ester, ethylhexyl - decyl phthalate, butyl-ethylhexyl phthalate, diallyl phthalate, butyl cyclohexyl phthalate, butyl benzy phthalate (BBP), di(methylcyclohexyl) phthalate, diphenyl phthalate, 2-ethyl hexyl isodecyl phthalate. Other phthalic acid derivatives such as the normal alcohol phthalate, alkoxy alkyl phthalate, for example the dibutoxy ethyl phthalate and fatty acid phthalates may be used in accordance with the present invention provided they are compatible with respect to polystyrene.

The alkyl or aryl radicals forming the phthalates in accordance with the present invention should have between 3 and 26 carbon atoms. The amount of the phthalate plasticizer should be at least 45 percent by weight of the polystyrene alone, exclusive of any monomer copolymerized with the polystyrene. Preferably, the amount of plasticizer should be approximately 90 to 110 percent of the weight of the polystyrene.

At elevated temperature of approximately 375 to 465° F. and preferably around 420° F. polystyrene will become liquid and when blended with the plasticizer, for instance

the di-isooctyl phthalate, the polystyrene and the phthalate appear to take the form of a reaction product. The identity or composition of the product so formed is not clear, nor is it certain that a reaction product does in fact take place. Analytical evidence and the combining quantities however do support the theory that at least a strong physical combination, if not a chemical bonding, takes place between the polystyrene and the phthalate plasticizer.

In order to obtain shape retention properties of the product produced from the combination of the polystyrene and the phthalate plasticizer and also to minimize cold flow, it has been found to be important to add a wax such as any natural or synthetic animal, vegetable or mineral wax. Such waxes are desirable to provide supporting means dispersed in the product to enable the user to retain the form or shape produced. When such waxes are used in an amount between 3 and 50 percent by weight of the polystyrene, the product is found to have desirable shape retention properties.

The waxes that may be utilized in accordance with the present invention are any of the animal, vegetable or mineral waxes such as beeswax, candelilla, carnauba, ceresene, insect wax, esparto, Japan, montan, ouricury, ozokerite, paraffin, spermaceti, sugar cane, wool fat. The preferred wax is paraffin wax which is a mixture of hydrocarbons melting in a range above 43° C. and which is a constituent of petroleum from which it may be distilled. Additionally, any of the paraffin hydrocarbon series of waxes having a carbon content of at least 16 carbon atoms such as for instance hexadecane, heptadecane, octadecane, etc., may also be used without limitation up through and including the C_{70} and greater hydrocarbons such as heptacontane. The mixtures as well as isomers of the paraffinic hydrocarbons are also useful for the purposes of this invention. Preferably, the amount of wax may vary from about 25 to 45 percent of the polystyrene.

The composition including the polystyrene, the plasticizer and the wax is usable without more as a moldable product. However, it does not have the unique characteristics of being able to radiate visual effects in reduced light. It has now been discovered that when a phosphor in an amount between .001 percent of the polystyrene is added to the plastic product that the unusual visual effects can be attained. Electroluminescent, fluorescent, and phosphorescent phosphors generally described as P_1–P_{30} may be used to achieve the visual effects of the present invention.

Typical, though by no means exhaustive, of the types of phosphors that may be used are those such as CaSrS:Bi; ZnCdS:Cu:Mg; SiO_2:Mg; CdS:Cu; ZnO; ZnS:Ni:Mn; ZnS:Cu:Mn; ZnS:Cu:Ag; (Zn, Cd) S:Ag. In general, any of the inorganic phosphors of the sulfide or oxide type may be usable as long as they are excited by sources of actinic radiation. Preferably those which are excited by sources readily available such as visible light or ultraviolet radiation are the most suitable. Since the phosphors vary considerably in the color of the radiation emitted, it is possible to use particular phosphors for obtaining almost any color.

In order to form the product of the invention, the styrene is heated to a liquid state which is between 375 and 465° F. (the melting temperature may be correspondingly varied in accordance with the identity of the copolymer). When the polystyrene is liquefied the phthalate such as di-isooctyl phthalate is blended and mixed with the polystyrene. It is believed that at this elevated temperature the polystyrene molecules are excited to the extent that the spacing between the molecules is increased such that the phthalate molecules are enabled to take a position betwen the polystyrene molecules. The preferred temperature is 420° F. The wax is added at the time after the phthalate plasticizer is completely blended. Thereafter the phosphors are added to provide the necessary glow properties.

EXAMPLE I

325 grams of polystyrene were heated to 420° F. and 400 grams of di-isooctyl phthalate were added and blended with agitation. Upon completion of the blending, 100 grams of paraffin wax and 35 grams of zinc sulfide, copper activated (ZnS:Cu) phosphor was added. Agitation is continued until a homogeneous product is obtained.

Upon cooling, it was found that the product may be stretched, severed, sculptured, molded in any manner and, upon activation from normal light present, the contained phosphor will provide a glow in the dark. It has further been found that irrespective of what shape or how stretched or molded the product has been, the glow will be uniform and homogeneous in appearance. More importantly, the glow will be of substantial magnitude, far greater than could be expected of phosphors on the surface. Depending upon the phosphor used, the glow will be retained for several minutes up to an hour or more.

One of the reasons for the magnitude of the glow has been found to be that the phosphors throughout the product contribute to the visible radiation. This is one of the unique facets of the present invention that the glow is not attained solely by surface phosphors but, due to the important radiation transmitting and almost transparent nature of the polystyrene phthalate and wax matrix, there is substantially no obstruction to the passage of the phosphor radiation from all contained phosphors through the matrix to obtain the full measure of the glow.

To the above composition, oleaginous materials such as Vaseline or any oil fats may be added if desired to provide purely a smoother, softer feel to the product. The addition of the Vaseline or other oleaginous material is not essential to the performance of the product.

Another of the unique characteristics of the product of the present invention is that the product will act as an image retaining means when impressed upon a surface such as paper which has been written upon with ball point pen or soft pencil and will transfer a portion of this image to another surface including the human skin or paper when impressed upon this other surface.

The product of the present invention is also nontoxic to humans and does not harden with nonuse. Shelf life has been found to be outstanding in tests performed to date.

It is also contemplated that as a toy or amusement device, the composition of the present invention may be formed in the shape of pellets or bullets and, if propelled as if shot from a gun in the dark, the bullets or pellets would glow and have the appearance of tracer or light bullets.

From the foregoing detailed description it will be evident that there are a number of changes, adaptations and modifications of the present invention which come within the province of those skilled in the art. However, it is intended that all such variations not departing from the spirit of the invention be considered as within the scope thereof as limited solely by the appended claims.

What is claimed is:

1. A moldable plastic product formed from polystyrene and at least 45 percent by weight polystyrene of a phthalate plasticizer selected from the group consisting of alkyl radical containing 3–26 carbon atoms, cycloalkyl, aryl, alkoxy alkyl, alkyl aryl, alcohol, fatty acid, dialkyl and diaryl phthalates, and including at least 3 percent up to 50% by weight polystyrene of a wax selected from the group consisting of natural and synthetic animal, vegetable and mineral waxes, and at least .001 percent by weight polystyrene of a phosphor.

2. The product of claim 1 wherein polystyrene is in the form of a copolymer and wherein at least 85 percent of the copolymer is polystyrene.

3. The product of claim 1 wherein the plasticizer is selected from the group of sulfide and oxide phosphors.

4. The product of claim 1 wherein the wax is a paraffin wax.

5. The product of claim 1 wherein the wax is a solid paraffinic hydrocarbon having a carbon content from 16–70.

6. The product of claim 1 wherein the plasticizer is a dioctyl phthalate and is present in the amount of 90 to 110 percent of the polystyrene.

7. The product of claim 4 wherein the paraffin is present in the amount of 25 to 40 percent of the polystyrene.

8. The product of claim 1 including a dioctyl phthalate as the plasticizer, a wax having a carbon content 16–70, and a phosphor selected from the group of sulfide and oxide phosphors.

9. The product of claim 1 wherein the plasticizer is present in the amount of 90–110 percent by weight of the polystyrene and the wax is present in an amount of 25 to 40 percent by weight of the polystyrene.

10. The product of claim 9 wherein the wax is a paraffin wax.

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