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TRANSPARENT RADIATION SHIELDS

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This invention concerns transparent shields for reducing the transmission of the harmful short wave length radiation, and more particularly concerns plastic compositions which can be molded or cast into flexible transparent articles for this use.

A serious problem in activities associated with the use of X-ray and other radiant energy generators is that of restricting the radiation to the activity concerned, and of protecting technicians, attendants and others who may be required, because of the nature of their duties, to be in the vicinity of scattered radiations for long periods of time.

For example, in the course of present day medical practice and procedure, technicians, attendants, and doctors are often required to remain throughout a substantial portion of the day in proximity to equipment which is generating X-rays for the purposes of X-ray fluoroscope examinations of the human body. Moreover, many radioactive isotopes are now being used in research work by chemists, physicists and others who are exposed to radiations emitted by these radioactive particles. Since the danger has been recognized, many protective measures have been designed to protect humans from these dangerous radiations. For instance, the X-ray generator used in fluoroscopic examinations is controlled to emit X-radiation over only a very short fraction of the total time such operators and attendants are in the fluoroscopic examination room. Radioactive isotopes and the like are normally retained in lead containers until incorporated in research activities and are then handled according to special safety procedures. Generally, protective shielding is provided in the walls and about the source of emitted radiation whether the radiation comes from radioactive particles or from an X-ray generator. In addition, persons dealing with these substances or exposed to X-ray radiation are usually encased in protective cells or housings in which they remain during the time that radiation is taking place.

Conventional protection against such scattered radiations has been sought through the use of protective barriers of considerable thickness, such as lead walls, concrete blocks impregnated with large quantities of lead, or shields covered with lead foil. For example, the entire working area immediately surrounding the products from which such radiations may be emitted has been encased in large lead or concrete housings, and remotely controllable means for handling and controlling the products have been provided for the operators, or the operators are confined to cells or protective enclosures of similar design and composition. Obviously, such protective means as are mentioned above as being in use are opaque and impose severe restrictions upon the ability of the technician engaged in such work to see what he is doing and to control the product. Some improvement in this situation has been derived from the use of lead glass which absorbs and scatters X-rays. These lead glass X-ray

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shields are transparent, but they are also brittle and rigid. They are also heavy and when used in large panes are not easily moved about.

Various plastic materials have been used in conjunction with lead particles or lead salts for the purposes of absorbing or deflecting X-ray. For instance, rubber and phenolic type polymers have both been used, but these compositions were not transparent and did not meet the need for a lightweight transparent protective shield. No method was taught by the prior art of combining the lightweight transparent characteristics of known polymeric materials with the protective quality of lead. However, we have discovered that a lightweight transparent flexible shield may be manufactured which will eliminate the above difficulties.

The object of this invention is to provide a transparent, flexible and tough plastic X-ray shield. Another object of this invention is to provide a method for manufacturing a transparent plastic X-ray shield. A further object of this invention is to provide a lead salt which may be dispersed in a suitable plastic material to impart X-ray absorbing properties to a screen made from this plastic.

We have found that quite surprisingly, the above objects are achieved by dispersing compatible lead salts in plastic polymeric compositions. The lead salt is dispersed in the composition by dissolving the lead salt in a solvent which will also dissolve the polymeric composition, and the mixture is then coated or molded to a desirable form. The lead salt may also be dispersed in the plastic polymeric composition by conventional rolling, blending, or extrusion mixing of the plastic and lead salt. The chemical composition and properties of the polymeric plastic determine which lead salt should be used. In our preferred embodiment of this invention we have used ethyl cellulose and the lead salt of 2-ethylhexoic acid which is 42% lead. We have discovered that various solvents may be used which are common to both ethyl cellulose and the lead salt. Among these solvents are toluene, benzene, methyl ethyl ketone, and acetone. However, when the materials are mixed without using a solvent, the lead salt can be dispersed in the ethyl cellulose by mixing on rolls heated to about 160° C.

Lead salts which may be used include, in addition to the lead salts of isobutyric acid and 2-ethylhexoic acid, lead salts of other branch chain acids, such as isovaleric, methylethyl acetic, trimethyl acetic, 2-methylhexoic, 5-methylhexoic, and 4-methyloctanoic.

The following examples illustrate the invention, which is not to be considered as limited thereto:

EXAMPLE I

Composition

41.7 parts ethyl cellulose (47.5% ethoxyl)
41.7 parts toluene
16.6 parts lead salt of 2-ethylhexoic acid which is 42% lead

Processing

The composition was mixed and formed into a pad by rolling between chromium plated rolls which were cooled to 60° C. by circulating water. The rolled pad was pressed between water cooled 12-inch platens under a pressure of 20,000 lbs. into a disc. The pressed disc was cured for 24 hours at 80° F. to a constant weight. The

cured disc was transparent, clear, tough and flexible. A section of the disc $\frac{3}{16}$ inch thick had the X-ray absorption power of a metallic lead shield .0024 inch thick. 0.1875 inch of the ethyl cellulose/lead salt composition provides protection from X-rays equal to 0.2" of concrete.

EXAMPLE II

A dope composed of

29.4 parts of ethyl cellulose (47.5% ethoxyl)
29.4 parts benzene
29.4 parts methyl ethyl ketone
11.8 parts lead salt of 2-ethylhexoic acid

was cast into a sheet by conventional coating procedures. The skin was transparent, clear, flexible and tough.

EXAMPLE III

A dope composed of

26.3 parts of ethyl cellulose (47.5% ethoxyl)
26.3 parts benzene
26.3 parts methyl ethyl ketone
21.1 parts of the 2-ethylhexoic acid lead salt

was cast into sheets by conventional methods. The cured sheet was flexible, tough, and transparent, although slightly hazy.

EXAMPLE IV

A composition containing

71.5 parts ethyl cellulose (47.5% ethoxyl)
28.5 parts lead salt of 2-ethylhexoic acid

was mixed on rolls heated with 160° C. steam. The rolled composition was pressed into discs between platens heated to 175° C. The pressed discs were tough, flexible, and transparent with an amber color.

EXAMPLE V

Composition

84.3 parts ethylcellulose (47.5% ethoxyl)
15.7 parts lead isobutyrate

Processing

The composition of cellulose ether and lead salt were mixed by rolling between chromium-plated rolls heated to 100° C. The composition was compression molded at 110° C. under 20,000 lbs. pressure into flexible, transparent, amber disc.

The X-ray absorption power of parts produced from these compositions may be increased by increasing the thickness of the plastic part or by increasing the concentration of lead salt in the composition. If the concentration of the lead salt of 2-ethylhexoic acid in compositions containing ethyl cellulose of 47.5% ethoxyl content exceeds 37.5% of the weight of the composition, the shields produced will be transparent but hazy.

It is apparent from the above description that X-ray shields formed by our invention have great utility and satisfy a long felt need, particularly with respect to the field of research with radioactive isotopes as well as in the field of X-ray therapy and examination. We have provided a new tool for the use of technical personnel who must, by the nature of their work, be in the vicinity of radiation a great part of the time. Now that we have made available a manner of making a transparent shield which may be molded to fit desired shapes, they will be better able to protect themselves from radiation, and at the same time be able to see their work more easily without leaving the protection of a protective device.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

What is claimed is:

1. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of ethyl cellulose and at least 10% by weight of a lead salt of a branched chain fatty acid.
2. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of ethyl cellulose and at least 10% by weight of the lead salt of 2-ethylhexoic acid.
3. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of about 41.7 parts by weight ethyl cellulose (47.5% ethoxyl) and about 16.6 parts by weight of the lead salt of 2-ethylhexoic acid.
4. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of about 29.4 parts by weight ethyl cellulose (47.5% ethoxyl) and about 11.8 parts by weight of the lead salt of 2-ethylhexoic acid.
5. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of about 26.3 parts by weight ethyl cellulose (47.5% ethoxyl) and about 21.1 parts by weight of the lead salt of 2-ethylhexoic acid.
6. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of about 71.5 parts by weight ethyl cellulose (47.5% ethoxyl) and about 28.5 parts by weight of the lead salt of 2-ethylhexoic acid.
7. A method for manufacturing a transparent shield for reducing the transmission of harmful short wave length radiations, comprising mixing at least 50% by weight ethyl cellulose and at least 10% by weight of the lead salt of 2-ethylhexoic acid on rolls heated to about 160° C. and pressing between platens heated to about 175° C.
8. A method of making a transparent plastic shield for reducing the transmission of harmful short wave length radiations, comprising dissolving at least 50% by weight ethyl cellulose and at least 10% by weight of the lead salt of 2-ethylhexoic acid into a solvent mixture of benzene and methyl ethyl ketone and casting in sheet form.
9. A method for manufacturing a transparent shield for reducing the transmission of harmful short wave length radiations, comprising mixing about 41.7 parts by weight of ethyl cellulose (47.5% ethoxyl), about 41.7 parts by weight of toluene and about 16.6 parts by weight of the lead salt of ethylhexoic acid, on rolls heated to about 160° C. and pressing between platens heated to about 175° C.
10. A method for making a transparent plastic shield for reducing the transmission of harmful short wave length radiations, comprising dissolving about 29.4 parts by weight of ethyl cellulose (47.5% ethoxyl), and about 11.8 parts by weight of the lead salt of 2-ethylhexoic acid into a solvent mixture of about 29.4 parts by weight of benzene and about 29.4 parts by weight of methyl ethyl ketone and casting in sheet form.
11. A method of making a transparent plastic shield for reducing the transmission of harmful short wave length radiations, comprising dissolving about 26.3 parts by weight of ethyl cellulose (47.5% ethoxyl) and about 21.1 parts by weight of the lead salt of 2-ethylhexoic acid into a solvent mixture of about 26.3 parts by weight benzene and about 26.3 parts by weight methyl ethyl ketone and casting in sheet form.
12. A method for manufacturing a transparent shield for reducing the transmission of harmful short wave length radiations, comprising mixing about 71.5 parts by weight of ethyl cellulose (47.5% ethoxyl) and about 28.5 parts by weight of the lead salt of 2-ethylhexoic acid on rolls heated to about 160° C. and pressing between platens heated to about 175° C.
13. A method of making a transparent plastic shield for reducing the transmission of harmful short wave

length radiations, comprising mixing about 84.3 parts by weight of ethyl cellulose and 15.7 parts by weight of lead isobutyrate on rolls heated to about 100° C. and pressing between platens heated to about 110° C.

14. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of ethyl cellulose and at least 10% of a lead salt of an acid selected from the group consisting of isobutyric, 2-ethylhexoic, isovaleric, methylethyl acetic, trimethyl acetic, 2-methylhexoic, 5-methylhexoic and 4-methylotanoic acids. 5 10

15. A transparent shield for reducing the transmission of harmful short wave length radiations, consisting essentially of from about 50 to 90 parts by weight ethyl cellulose and from about 10 to 50 parts by weight of the lead salt of 2-ethylhexoic acid. 15

16. A method of making a transparent plastic shield

for reducing the transmission of harmful short wave length radiations, comprising mixing from about 50 to 90 parts by weight of ethyl cellulose and from about 10 to 50 parts by weight of the lead salt of 2-ethylhexoic acid.

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