

[54] **PRESSURE SENSITIVE EXPLOSIVE WITH ORGANOSILANE COATING**

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[58] Field of Search 149/11, 35, 92, 93, 149/105, 19, 7, 29, 85, 31; 102/8

[56] **References Cited**

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[57] **ABSTRACT**

A pressure sensitive explosive composition is provided which is rendered insensitive to water or water vapor by means of a coating of an organofunctional silane capable of polymerization on contact with water or water vapor. Additionally, a method is provided of coating such a composition by the use of the above-mentioned silane in a halocarbon solvent having a relatively low vapor pressure at ambient conditions. The composition may be a mixture of an inorganic oxidizer and fuel such as potassium chlorate, red phosphorous and ground glass or a mixture of a primary explosive such as lead azide and a secondary explosive such as RDX, either mixture being coated with a silane such as γ (β aminoethyl) aminopropyl trimethoxy silane applied from a volatile halocarbon liquid such as 1,1,2 trichloro-1,2,2 trifluoro ethane. The silane, after evaporation of the liquid, coats the composition and polymerizes on contact with water or water vapor to form a water impermeable film and this renders the composition insensitive to water deactivation.

5 Claims, No Drawings

PRESSURE SENSITIVE EXPLOSIVE WITH ORGANOSILANE COATING

The invention described herein may be manufactured, used and licensed by or for the Government for governmental purposes without the payment to me of any royalty thereon.

BACKGROUND OF THE INVENTION

For certain battlefield applications, it is desirable to deploy a large number of packaged explosives over a pre-selected area of the battlefield. Aircraft dispersal is the most convenient method of deployment. This type of dispersal requires maintenance of the packages in a substantially insensitive state until after they hit the ground. An effective, economical method for fabrication of these packages is accomplished by placing the explosive in a vapor permeable container and filling the container with a desensitizing liquid, which will permeate the container. After the package is deployed the liquid will evaporate through the container and leave the enclosed explosive armed. One of the principal drawbacks of this type of system is the possibility of premature desensitization of the explosive by water or water vapor. For example, rainfall will cause moisture permeation of the package and permanently desensitize the explosive before it can effectively function. Additionally, a very humid atmosphere has a strong tendency to effect premature complete desensitization due to permeation of the package by water vapor.

The difficulty thus encountered is of relatively recent origin and although many organic compounds, including silanes and siloxanes have been used for various purposes with energetic components (see for example U. S. Pat. Nos. 3,551,222; 3,404,061; 3,058,858; 3,190,775; 3,190,776 and 3,110,638), these uses were neither analogous to the instant problem nor indicative of a solution thereto.

It is, therefore, an object of this invention to provide an explosive composition which is insensitive to moisture.

Another object is to furnish a method of rendering an explosive composition insensitive to moisture.

A further object is to provide a moisture insensitive, pressure sensitive, explosive composition for use in antipersonnel mines.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same become better understood by reference to the following description, wherein it is shown that the above mentioned objects are attained and the prior art deficiencies are overcome by the use of an organo-functional silane monomer in a solvent solution to coat all of the components of an explosive composition and thus render the composition insensitive to water vapor, or water.

DESCRIPTION OF A PREFERRED EMBODIMENT

Certain types of mines have been used which are dispersed over a preselected area of a battlefield by air drop. These mines must be maintained in an insensitive condition until they hit the ground. One advantageous method of accomplishing this is by using a pressure sensitive explosive or pyrotechnic composition immersed in a desensitizing liquid, the whole being enclosed in a container which is permeable to the vapor of the desensitizing liquid. By the use of this method the mines could be deployed while insensitive and then become

armed through the evaporation of the desensitizing liquid. On standing in a humid atmosphere or in a rainstorm, the contained explosive or pyrotechnic tended to become inert because of sorption of water vapor or actual inundation by rain water. I have found that by adding a soluble, organo-functional silane monomer, which polymerizes on contact with water vapor, to the desensitizing liquid and by intimately mixing the resultant solution with the selected explosive or pyrotechnic composition, a mixture is formed which will leave a coating of silane monomer on the explosive composition when the desensitizing liquid volatilizes on standing. Since the monomer polymerizes on contact with water vapor and since the polymer thus formed is not permeable to water or water vapor, this coating provides a means of making the explosive or pyrotechnic composition insensitive to moisture. I have also found that this polymer coating does not interfere with the pressure sensitivity necessary to ultimately activate a mine.

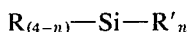
Indeed, my invention need not be used exclusively with a mine, it may be used with any compatible explosive or pyrotechnic composition which must be protected from moisture either vapor or liquid.

The solvent liquid used with my invention must be capable of dissolving the silane monomer and additionally possess the properties of non-reactivity and non-solvation with the explosive, non-reactivity with the organo-functional silane monomer and a vapor pressure, such that the liquid will evaporate in a relatively short time at ambient temperatures, thus in effect resulting in a reversibly desensitized mine. Additionally, if my invention is to be used with the type of mine described, the liquid solvent must be capable of desensitizing the explosive or pyrotechnic while the explosive is still thoroughly wetted by the liquid. Any liquid which will meet these criteria can be used.

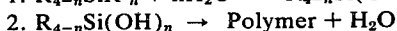
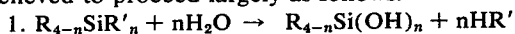
It has been found that halocarbons of a chain length of one or two carbon atoms containing at least one halogen substituent are preferable, for example Freon 113 or perchloroethylene. These halocarbons preferably have a boiling point between about 30°C and about 120°C. Other preferred halocarbons are 1,1,2 trichloro-1,2,2 trifluoroethane; 1,1,2,2 tetrachloro-1,2 difluoroethane; 1,1,2,2 tetrafluoro-1,2 dibromoethane; carbon tetrachloride and tetrachloroethylene. Additionally, when the organo-functional silane is a liquid of sufficiently low viscosity, it can be readily mixed with the explosive and it will not be necessary to use a desensitizing liquid. This procedure, although effective is not preferred because of attendant hazardous mixing conditions. My invention can be utilized for protection of any solid explosive composition susceptible to desensitization by moisture, for example: mixtures of red phosphorous, a strong inorganic oxidizer such as potassium chlorate or perchlorate and ground glass and pressure sensitive mixtures of primary explosives such as lead azide or lead styphnate and secondary explosives such as RDX, PETN or HMX.

My invention utilizes organo-functional silane monomers capable of reacting with moisture at atmospheric temperatures to form a water impermeable polymer.

The monomer must be soluble in the desensitization liquid and adhere strongly to the solid explosive or pyrotechnic substrate. This is usually accomplished either during the immersion of the substrate in the liquid or upon substantial volatilization of the liquid thus leaving a monomeric coating. Additionally, the monomer must be capable of forming a moisture impervious coating of polymer upon contact with water or water vapor. Further, the coating must not prevent initiation of the explosive. The total amount of silane monomer used will depend on the amount of surface area of explosive substrate because a complete coating is desired. Additionally, the amount used must not be enough to cause excessive desensitization. I have found that between about 1% and 5% by weight of monomer, based on the amount of explosive or pyrotechnic substrate, will give satisfactory results. 2% by weight is preferred. Organo-functional silanes capable of use with my invention are well known and can be represented by the general formula,



wherein Si represents a silicon atom, at least one of the R substituents is selected from the group consisting of halogen, amino, alkoxy and aryloxy and R' represents a substituent selected from the group consisting of alkyl, aryl, aminoalkyl, aminoaryl, alkylamino, arylamino, alkoxy and aryloxy and n is an integer from 1 to 3 inclusive. Generally, the reaction of such an organo-functional silane to effect protection against moisture for the composition of my invention is thought to be a hydrolytic polycondensation which is believed to proceed largely as follows:



wherein R, R' and n have the aforementioned definitions. The silanol product of reaction (1) is unstable and reacts further to form a polymeric silicon containing material. In some cases a siloxane is formed, in other cases a cyclic polymer and in yet others a polyorganosiloxane. The type of polymer formed depends upon the type and number of the R and R' substituents. R is selected for its ability to hydrolyze to form the necessary intermediate silanol and R' is selected for its ability to lend water impermeability to the formed polymer. Generally, where R is alkoxy it will be a short chain i.e. from one to four carbon atoms. Additionally, the polymerization rate also depends on the substituents selected. Since the purpose of my invention is broadly to provide protection against water and water vapor, the polymerization rate should be relatively rapid upon contact with water or water vapor.

Some examples of silanes that may be used with my invention, follow: γ (β aminoethyl) aminopropyl trimethoxy silane; γ aminopropyl triethoxy silane; methyl triethoxysilane; phenyltrichlorosilane; n butyltrichlorosilane; dimethyl dichlorosilane and methyl phenyldichlorosilane.

In certain cases catalysts which are soluble in the liquid used as a desensitizing solvent may be added to insure polymerization of the monomer if they are compatible with the ultimate function of the explosive or pyrotechnic composition.

The method and composition of this invention, which may be used to produce a safe desensitized explosive item having the properties desired, are set forth in the following examples. It is, of course, understood that

these examples are meant to be illustrative and not restrictive of my invention.

EXAMPLE 1

A one percent solution of γ (β aminoethyl) aminopropyl trimethoxy silane in 10 cc. of 1,1,2 trichloro-1,2,2 trifluoro ethane was prepared under dry conditions. 0.2 gram of fumed silica thickening agent and then 5 grams of potassium chlorate were added to the solution with agitation. 2 grams of red phosphorous were then added and the resulting desensitized slurry was agitated until homogeneous. 1 gram of cut pyrex glass was added to a small polyethylene cup under dry conditions and dampened with 1,1,2 trichloro-1,2,2 trifluoro ethane. 3 grams of the desensitized slurry was added to the cup and then the cup was closed with a rigid polyethylene disc and heat sealed. The cup was conditioned at a specified temperature and relative humidity and subsequently tested for effectiveness by standard tests. The polyethylene cup and disc were made from Alathon A 3120 film (a registered trademark of E. I. DuPont de Nemours Co.), this product, marketed by DuPont, was found suitable for the present application.

EXAMPLE 2

Using the same procedure as in Example 1, but in place of the potassium chlorate, red phosphorous and ground glass, enough RDX and lead azide is introduced into the halocarbon, silane, silica slurry to form a final mixture containing 60 parts by weight of RDX to 40 parts by weight of lead azide.

RESULTS

Ten of the cups were prepared by the method of Example 1, and allowed to stand at ambient temperature and humidity until the solvent was removed by evaporation. After a predetermined time five of the cups were detonated and the pressure required to cause detonation was recorded. The pressure required to initiate the detonation of the cups fell between 6 and 8 psi which compared favorably with control cups identically prepared without the silane additive. The remaining 5 cups were placed in a 95 percent relative humidity chamber at room temperature for humidity testing. Two cups were removed after 7 days and tested; one of the cups detonated at 6 psi, the other required 16 psi. Three cups were removed after 14 days in the chamber and tested; one of the cups detonated at 9 psi, the other two required 38 psi and 40 psi respectively.

These results indicate that there is no apparent desensitization of the explosive by the addition of silane as shown by the comparability of the pressure required to detonate the test cups and the pressure required to detonate control cups prepared without silane. Additionally, with the 7 day test, since one of the samples was in line with the necessary standard control pressure, the indication is that the silane has provided water vapor protection. The second result which was high may indicate poor coverage by the silane due to inhomogeneity of the original mixture. The test after 14 days indicates the same water vapor protection evident in one of the samples while the other two high results may again indicate inhomogeneity.

Thus, it can be seen that the use of my invention, wherein an explosive composition is coated with a water reactive organo-functional silane monomer to prevent detrimental contact of the explosive by moisture, forms the basis for an advance in the art.

I wish it to be understood that I do not desire to be limited to the exact details described, for obvious modifications will occur to a person skilled in the art.

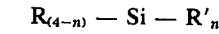
I claim:

1. A pressure sensitive, moisture insensitive, explosive composition for use in pressure sensitive antipersonnel mines comprising a particulate, pressure sensitive explosive composition selected from the group consisting of a mixture of an inorganic oxidizer, red phosphorus and ground glass and a mixture of a primary explosive selected from the group consisting of lead azide and lead styphnate and a secondary explosive selected from the group consisting of cyclotrimethylenetrinitramine, pentaerythritol tetranitrate and cyclotetromethylenetetranitramine, wherein the particles are coated with an organo-functional silane monomer capable of reacting with atmospheric moisture at atmospheric temperatures to form a water impermeable polymer.

2. A composition as defined in claim 1 wherein said inorganic oxidizer is selected from the group consisting

of potassium chlorate and potassium perchlorate.

3. A composition as defined in claim 1 wherein said organo-functional silane monomer has the general formula



wherein R is a radical selected from the group consisting of halogen, amino, alkoxy and arlyoxy, R' is a radical selected from the group consisting of alkyl, aryl, aminoalkyl, aminoaryl, alkylamino and arylamino, and n is an integer from 1 to 3 inclusive.

4. A composition as defined in claim 3 wherein said organo-functional silane monomer is selected from the group consisting of γ (β aminoethyl) aminopropyl trimethoxy silane; γ aminopropyl triethoxysilane, methyl triethoxysilane, phenyltrichlorosilane, n butyl trichlorosilane, dimethyl dichlorosilane and methyl phenyl dichlorosilane.

5. A composition as defined in claim 3, wherein the amount of said monomer is between about 1 percent and 5 percent by weight of said explosive composition.

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