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PROCESS FOR PREPARING A METALLIZED EXPLOSIVE

Frank D. Patrick, Freeport, Tex., assignor to The Dow Chemical Company, Midland, Mich., a corporation of Delaware

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This invention relates to explosives and more particularly is concerned with a novel process for preparing an explosive composition having a substantially uniform distribution of fine metal particles therein.

The use of finely divided metal particles as sensitizers and/or fuel components in explosive compositions is well known in the explosives art. However, because of their density and low bulk volume per unit mass, when such metal particles are employed with an oxidizer or explosive component, particularly with liquid materials or free-flowing bulk materials, they tend to settle out in the composition. Therefore, to obtain and maintain suspension of such metals throughout the composition, the mix must be continuously agitated and/or a gelling or thickening agent must be employed.

With explosives employing larger metal particles wherein these are of such a shape, size or configuration to be substantially self-supporting, e.g. form a core with interconnecting cavities, and, may be of such a bulk density so as to achieve co-volume with the oxidizer or explosive component this settling is not a problem. However, many times it is advantageous to provide a mixture of coarse and fine metal particles to facilitate the explosive reactivity of the mix. To illustrate, small metal particles, which ordinarily are readily ignitable, when employed in a mixture with coarser metal particles, can serve as initiation sites, reaction promoters and a "kindle" for the larger particles.

It is a principal advantage of the present invention to provide a novel process for preparing a metallized explosive wherein finely divided metal particles are substantially uniformly distributed throughout an explosive composition.

It is also an object of the present invention to provide a novel process for assuring that in a metallized explosive composition employing both fine metal particles and coarse metal particles there is no settling of the fine metal particles in the composition without having to employ gelling or thickening agents therein.

It is an additional object of the present invention to provide a process for preparing a metallized explosive wherein metal particles are in closer contact than results from a simple physical mixture of particles and therefore renders these more effective.

It is a further object of the present invention to provide a process for rendering more sensitive to detonation explosives metallized with coarse metal particles.

These and other objects and advantages readily will become apparent from the detailed description presented hereinafter.

In carrying out the present novel process, coarse particles of a light metal are contacted with a second light metal in a manner so as to provide a multiplicity of finely divided particles of the said second light metal dispersed over and affixed onto the surface of said first light metal coarse particles. The resulting coarse metal-finely divided metal composite is admixed with an explosive or oxidizer component which gives an explosive composition when mixed with the metal thereby to provide a metallized explosive having a distribution of fine metal particles positioned throughout the final product.

The term "light metal" as used herein is meant to include magnesium, aluminum, magnesium alloys, aluminum alloys and the like light metals and mixtures thereof. "Magnesium alloys" refers to those metals having at least about 70 percent aluminum. "Aluminum alloys" refers to those metals having at least about 70 percent aluminum.

The term "coarse metal particles" as used herein is meant to include slab face scalpings, machine turnings, Grignard chips, chopped scrap, millings, foils, strands, needles, bars, sponges, tubes and the like. These particles may be one quarter inch or more in diameter and four to six inches or more in length. To illustrate, commercially available magnesium Grignard chips pharmaceutical grade have the following approximate dimensions; about .010" (thickness) x 0.125" (height) x 0.50" (length). In general, these particles are of such a congfiuration so as to be non-equiaxed. Preferably, these coarse particles when utilized in an explosive composition will be of such a configuration and present in such a concentration so as to provide a self-supporting core or structure having interconnected channels or passages. The oxidizer or explosive component is introduced into the interconnected cavities or channels to provide a final composition wherein the metal core and oxidizer or explosive component both coextend substantially over the entire volume occupied by the composition.

"Finely divided particles" means materials wherein the substantial portion pass a No. 40 U.S. Standard Sieve and wherein the majority of the individual particles are a maximum size of about 100 mesh U.S. Standard Sieve.

The introduction onto or joining of the fine metal particles to the surface of the coarse metal readily is achieved by metal spraying techniques, e.g. flame spraying as by a wire-fed metallizing gun, adhesively affixing one to the other, heating one or the other of the metal forms and pressure joining the heated and cool metal together, etc. The amount of fine particles affixed to the coarse particulate metal can be predetermined over a wide range of concentrations depending on the ratio of coarse to fine particles to be present in the final mix. The sprayed metal can be from about 10 to about 90 percent by weight of the coarse particles. For most effective use in an explosive composition, the surface of the coarse particle is not entirely covered with the finely divided particulate material, but rather this forms a discontinuous series of individual particles thereon. To illustrate, magnesium slab-faced scalping chips (having an average thickness of from about 1/64 to 1/32 inch, a width of about ½ inch and a length of about 1½ inches) were sprayed with aluminum using a metallizing wire-gun to provide a 50–50 weight percent composite of fine-coarse particulate metal. Measurement of the aluminum particles attached to the slab face scalpings indicated a size distribution such that about 35 percent of the aluminum particles passed a 40 mesh U.S. Standard Sieve but would have been retained on a 100 mesh U.S. Standard Sieve, about 31 percent were of a diameter so as to pass a 100 mesh but would be retained on a 200 mesh Standard Sieve, about 21% would have passed a 200 mesh but would be retained on a 325 U.S. Standard Sieve and about 6 percent were minus 325 mesh U.S. Standard Sieve size particles.

It is to be understood that in the present process, coarse and fine particles of like metals can be joined. Likewise dissimilar metals can be attached one to the other. To illustrate, for example, aluminum can be sprayed onto coarse magnesium chips as set forth hereinbefore; finely divided aluminum alloy particles can be formed on a matrix of a coarse aluminum chip prepared in a lathe designed for preparing Grignard chips; fine magnesium particles can be splattered onto coarse aluminum curled chips; and, finely divided particulate magnesium can be affixed to readily available magnesium Grignard chips.

The so-prepared metal particles can be employed with any of a wide variety of traditional explosives or oxi-

dizers which will provide an explosive composition. Particularly suitable explosives and oxidizers include for example, ammonium nitrate, TNT, free flowing dynamites, black powder, and the like.

An effective explosive is obtained when the so-prepared fine-coarse metallized particles are shaped into a self-supporting core and an aqueous, ammoniacal or aqueous-ammoniacal solution of ammonium nitrate substantially saturated with respect to the ammonium nitrate is added thereto to provide substantially coextensive volumes of metal and oxidizer. Divers Solution (ammonium nitrate dissolved in ammonia) or commercially available solutions substantially saturated with ammonium nitrate dissolved in ammonia and having from about 4 to about 7 percent by weight water or more are preferred oxidizer solutions.

The following examples will serve to further illustrate the present invention but are not meant to limit it thereto.

Example 1

A quantity of magnesium slab-faced scalping chips were spray coated with aluminum to provide a metallized product having about a 50/50 weight ratio of magnesium and aluminum. Particle size distribution of the resulting aluminum particles on the magnesium surfaces indicated an approximate range (effective diameter) equivalent to the following U.S. Standard Sieve analysis: −20+40 mesh—8%, −40+100 mesh—35%, −100+200 mesh—31%, −200+325 mesh—21% and −325 mesh—5%. The resulting metal produce clearly showed a magnesium matrix with the small aluminum particles randomly affixed to the surface thereof.

About 2 pounds of the metal particles were placed in a 5 inch diameter x 6 inch high container forming a self-supporting core. About 3 pounds of an aqueous ammoniacal ammonium nitrate solution (approximate composition 69.2 percent ammonium nitrate—25.3 percent ammonia—5.5% water) was poured over the chips and filled the container approximately to the top level of the packed metal chips. 2A Procore (160 gram) explosive initiating booster was centered in the mix, this being attached to a 50 grains per foot Primacord detonating fuse. The Primacord fuse was pulled through the lid of the container and the container then sealed. The free end of the Primacord fuse was armed with a No. 6 electric blasting cap attached by a lead line to an initiator. The load was buried about 38 inches in beach sand and detonated. Good detonation resulted producing a crater having a diameter of about 10.3 feet and a depth of about 3.2 feet.

Example 2

A 5 lb. explosive load prepared in accordance with the teaching of Example 1 was subjected to the standard military rifle bullet sensitivity test as reported in "Military Explosives," Department of The Army Technical Manual TM9–1910, Department of the Air Force Technical order TO11A–1–34, p. 49. Complete detonation was achieved.

As a control, unmetallized (i.e. not having fine particles affixed thereto) magnesium slab-faced scalping and aluminum turnings in the same weight proportion were physically blended and utilized with Divers Solution in a substantially identical explosive composition. This latter composition gave no veidence of detonation when subjected to the standard military rifle bullet test.

In a manner similar to the foregoing, magnesium sprayed aluminum chips can be utilized with TNT; fine particles of magnesium alloy can be affixed to magnesium machine turnings and these blended with free flowing dynamite; a mixture of finely divided aluminum and magnesium particles can be affixed to the surface of coarse aluminum alloy chips and these employed in with ammonium nitrate oxidizer to prepare an explosive composition.

Various modifications can be made in the present invention without departing from the spirit or scope thereof for it is understood that I limit myself only as defined in the appended claims.

I claim:

1. A novel process for preparing a metallized explosive composition which comprises;

(a) providing a source of coarse nonequiaxed particles of a first light metal,

(b) flame-spraying a multiplicity of finely divided particles of a second light metal onto the surface of said coarse particles thereby to provide a composite fine-coarse metal particle, said finely divided particles of said second light metal forming a discontinuous series of individual particles on said coarse nonequiaxed particles of said first light metal and said finely divided particles of said second light metal not entirely covering the surface of said coarse particles of said first light metal, said coarse particles consisting of from about 10 to about 90 weight percent of said composite and said finely divided particles consisting of from about 90 to about 10 weight percent of said composite, said first light metal and said second light metal being selected from the group consisting of magnesium, aluminum, magnesium alloys and aluminum alloys, and

(c) admixing an explosive member therewith.

2. A process for preparing a metallized explosive which comprises;

(a) providing a source of coarse nonequiaxed magnesium chips;

(b) flame-spraying aluminum onto the surface of said chips thereby to firmly affix finely divided aluminum particles onto the surface of said coarse magnesium chips, the flame-sprayed aluminum particles being of a size such that the substitial portion pass a No. 40 U.S. Standard Sieve, the aluminum-magnesium content of the resulting fine-coarse particulate metal composite being about 50 weight percent aluminum and about 50 weight percent magnesium, said aluminum particles forming a discontinuous series of individual particles on said magnesium chips and said aluminum particles not entirely covering the surface of said magnesium chips, and

(c) admixing about 40 parts by weight of said fine-coarse particulated metal composite with about 60 parts by weight of an ammonium nitrate solution, said ammonium nitrate solution being a substantially saturated solution of ammonium nitrate in a solvent selected from the group consisting of water, ammonia and mixtures thereof.

3. The process as defined in claim **2** wherein Divers Solution is admixed with said composite fine-coarse particulate light metal.

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CARL D. QUARFORTH, *Primary Examiner.*

REUBEN EPSTEIN, *Examiner.*