The present invention relates to a non-pyrotechnic, self-illuminating projectile useful for marking, target illumination, or targeting adjustment which produces chemiluminescent light upon impact with an object. Because the production of light is delayed until impact, the projectile is not visualized until impact and the intensity of light upon impact is greater than light produced by projectiles that provide intermixing of light generating chemicals during flight.
CHEMILUMINESCENT IMPACT ACTIVATED PROJECTILE

CROSS REFERENCE TO RELATED APPLICATIONS

FIELD OF THE INVENTION
[0002] This invention relates to light emitting projectiles for marking an impact area, more particularly to a long range, long-flight time chemiluminescent projectile used for tactical and training exercises by military and law enforcement personnel which prevents light production resulting from forces associated with firing of the weapon, thereby retaining the amount of chemical light generated to occur as the projectile impacts the target area and releases its contents.

BACKGROUND OF THE INVENTION
[0003] Military and law enforcement personnel worldwide employ a variety of projectile launching weapons, both direct-fire and ballistic in nature. Payloads include lethal and non-lethal explosive charges, chemical agents such as tear gas, smoke, and combinations of elements to illuminate an area or target for remote reconnaissance. In addition, in the training of military and law enforcement personnel, a need exists for detecting the accuracy and effectiveness of the trainee’s ability to strike an intended target in daylight or darkness. This is important not only for personnel training, but also to determine the effectiveness of various equipment systems, and as a means of calibrating such systems. Training with explosive or pyrotechnic devices presents inherent health and safety hazards to the training personnel, such as in the case where a pyrotechnic charge fails to perform as required, resulting in unexploded ordinance.

[0004] Various devices are currently employed for marking the destination of projectiles. Many such devices utilize pyrotechnics which produce a flash of light and smoke to indicate the projectile impact site. One such device employs titanium tetrachloride which produces a cloud of smoke when it reacts with the moisture in the air on impact. A second such device is a red phosphorus bearing projectile which emits a flash of light upon impact. These devices, however, have inherent problems. Devices utilizing titanium tetrachloride, are ineffective for night time detection as they only emit smoke. Devices utilizing phosphorus generate light and can be seen during day or night time. However, light production is a result of burning, resulting in fire hazard potential for any materials, such as trees, shrubs, or grasses, that my contact the burning phosphorus.

[0005] Chemiluminescent lighting devices have been used as an alternative to devices utilizing pyrotechnics. Chemiluminescent systems provide light by the use of a chemical reaction not dependent upon any electrical power or batteries. The long storage life and the excellent quality of light produced from current chemiluminescent systems have made the product a mainstay in the industry for emergencies. Projectiles utilizing chemiluminescent systems have an advantage in that they do not utilize pyrotechnics, and therefore are not a source of ignition for objects which come into contact with the chemicals. They are also useful in day and night detection and can produce both visible and non-visible light.

[0006] Chemiluminescent light production generally utilizes a two-component system to chemically generate light. Light is produced by combining the two components, which are usually in the form of chemical solutions referred to as the “oxalate” component and the “activator” component. The two components are kept physically separate by a sealed, frangible, glass vial containing one component which is housed within an outer flexible container containing the other component. Typically, this outer container is sealed to contain both the second component and the filled, frangible vial. Forces created by intimate contact with the internal vial, e.g., by flexing, cause the vial to rupture, thereby releasing the first component, allowing the first and second components to mix and produce light. Since the objective of this type of device is to produce usable light output, the outer vessel is usually composed of a clear or translucent material, such as polyethylene or polypropylene, which permits the light produced by the chemiluminescent system to be transmitted through the vessel walls. These devices may be designed so as to transmit a variety of colors by either the addition of a dye or fluorescent compound to one or both of the chemiluminescent reactant compositions or to the vessel. Furthermore, the device may be modified so as to only transmit light from particularly chosen portions thereof.

[0007] Chemiluminescent projectiles are currently used by the military to provide tracking and marking capabilities, thus eliminating training with explosive or pyrotechnic devices which present inherent health and safety hazards to the training personnel. In many cases, however, military forces training on gunnery accuracy in larger calibers (40 mm to 155 mm) often desire to train with non-explosive chemiluminescent ammunition. Typical chemical light reactions initiate with a bright burst of light that quickly diminishes and then asymptotically approaches zero. Approximately 80% of the available light is emitted within the first 20% of the total glow duration. When training for accuracy, a brief, bright burst of light is desired that rapidly extinguishes so that the impact of subsequent rounds can be accurately determined. Chemical light training munitions have their formulas catalyzed such that the entire reaction occurs in approximately one minute. In larger, long range calibers, chemiluminescent munitions that produce light upon the firing of the weapon, in combination with the long flight times, can result in a majority of the chemical light reaction occurring before the munition impacts the target area and releases its signal.

PRIOR ART
[0008] The production of devices capable of emitting light through chemical means is well-known in the art. Lightsticks, for example, are taught in U.S. Pat. No. 3,539,794, while other configurations have also been the subject of many U.S. patents, e.g., U.S. Pat. Nos. 3,749,620; 3,808,414; 3,893,938; 4,635,166; 4,814,949 and 5,121,302, the contents of which are herein incorporated by reference.

[0009] Various chemiluminescent and non-chemiluminescent projectiles have been developed which provide marking and tracking capabilities. U.S. Pat. No. 3,940,605 discloses a chemiluminescent lighting apparatus for generating an illuminated marker material for delivery to a desired area. Two fluids to be mixed are contained in separate chambers and are
separated from a mixing chamber by means of frangible disc-shaped members. A hollow gas generator expels gas when a squib fractures one of its walls. The force of the escaping gas exerts pressure on the two fluids sufficient to fracture the frangible disc members allowing mixing action in the mixing chamber. The mixed fluid chemically reacts to produce light and flows from the mixing chamber to a light transmittable material where it is stored to provide an illuminated area.

[0010] U.S. Pat. No. 3,983,817 discloses a spotting projectile having an interior cylinder receiving a piston in gas-sealing slideable relation so that gas trapped in the cylinder is compressed by forward inertial movement of the piston when the projectile impacts. The compressed gas ejects a powder charge carried by the piston rearwardly from the projectile to form a visible cloud.

[0011] U.S. Pat. Nos. 4,640,193 and 4,682,544 teach a container adapted for insertion into a device wherein the container has fitted into its hollow interior the components required to form therein and eject therefrom, upon impact and detonation, a chemiluminescent light emitting material, inclusive of a reactive enhancer.

[0012] U.S. Pat. No. 4,932,672 discloses an impact actuated nonlethal hand grenade having a flexible, resilient casing containing a pressurized marking fluid. The casing has an opening and a ball received within the opening, whereby, when the hand grenade is thrown, the subsequent impact of the grenade with an object and the resulting hydrostatic shock through the fluid within the grenade will dislodge the ball from the opening allowing the discharge of fluid from the opening and onto surrounding objects.

[0013] U.S. Pat. No. 4,944,521 discloses a war game marking grenade with a piercing mechanism to pierce an enclosed gas cylinder. The gas from the cylinder is directed into channels and impels gelatin enclosing fluid marking spheres exteriorly of the grenade for marking purposes.

[0014] U.S. Pat. No. 5,018,449 discloses a paint dispersing training grenade that includes a grenade body having dispersing passages, a plug received in one end of the bore, a piston resiliently urged by a spring toward the plug, a rupturable colorant containing capsule positioned between the piston and the plug, a separable release lever, and an inertial delay mechanism engaged between the grenade body and the piston. The delay mechanism includes pivotable delay levers engaged with the piston at one end and having wheels reliably engaging a surface of the grenade body at another end. When the release lever is separated, movement of the piston by the spring is resisted by startup inertia of the wheels in rotating. When the inertia is overcome, the piston forcibly ruptures the capsule and propels the colorant out of the grenade body through the dispersing passages.

[0015] U.S. Pat. No. 5,018,540 teaches a luminescent paintball which comprises a double chamber projectile capsule that contains two chemical agents which, when mixed together on impact, provide a chemically luminescent spot for marking at night. The chambers are provided with a double barrier which assures necessary shelf life and complete separation of the active ingredients.

[0016] U.S. Pat. No. 5,035,183 discloses a two-piece polymer projectile consisting of an aero dynamically shaped, thin-shelled, frangible cap, adapted to be filled with a flowable substance for marking upon impact, the fluid sealed within the projectile by a rear plug. The rear plug is relatively rigid in order to contain the expansive effect of propellant gases; a recessed compartment in the rear plug contributes to creating a forward center of gravity for the projectile, the barrel rifling is engaged by the projectile in the region of the rear plug only, whereby positive engagement with the barrel rifling imparts spin without bursting the cap portion of the projectile; an indentation region on the nose of the cap facilitates flexing of the score lines for rapid and efficient bursting of the cap on impact.

[0017] U.S. Pat. No. 5,257,916 discloses an inert training grenade intended to be fired by a rifle and a propellant cartridge, comprising a metal tube and with a front solid part which closes off the tube. This front part carries a hollow nose containing a marking substance. The nose is sufficiently resistant to withstand the shot, but is destructible on impact.

[0018] U.S. Pat. No. 5,590,866 discloses a reusable, mechanically powered Paint Ball Grenade utilizing 0.68 or smaller diameter paint balls. Once thrown downward the actuator will function upon impact allowing the grenade halves to collapse with the force of the primary spring, crushing the paint balls against cutters and causing the paint to be hydro mechanically dispersed about the exterior of the device.

[0019] U.S. Pat. No. 6,619,211 discloses a practice ammunition projectile comprises a head which bursts when the projectile strikes a target and contains a marking agent which optically indicates the point of impact after the head has burst. The marking agent consists of several chemical components which are each contained in separately breakable compartments within a burstable hood at the head of the projectile.

[0020] U.S. Pat. No. 6,931,993 discloses a chemiluminescent tracer/marker munition design where the projectiles are activated upon launch and travel either independently from the gun (e.g. scatter pattern) or are dispensed after a containment housing opens after firing.

[0021] U.S. Pat. No. 6,990,905 discloses a non-lethal chemiluminescent marking projectile that provides site identification capability of a target upon impact. The projectile contains a breakable container system and a foam filler. The container system breaks on a setback impact that is exerted during firing and initial launch, causing the chemiluminescent reagents to mix and be absorbed into the foam filler, such that upon impact of the projectile with the target, the foam filler marks the target with the mixed chemiluminescent reagents diffused therein.

[0022] U.S. Pat. No. 7,055,438 discloses a flameless tracer/marker consisting of a hollow frangible projectile containing bags or ampoules containing the reagents required for the desired target effect are ruptured by the force of impact upon the target, allowing said reagents to intermix and disperse whereas the projectile shatters on impact.

[0023] U.S. Pat. No. RE 40,482 discloses chemiluminescent training munitions that activate or break the chemiluminescent material containing frangible containers upon setback or firing of the munition.

[0024] While each of the cited prior art references describe marking projectiles, these projectiles have proven less effective for providing a training projectiles that 1) does not utilize pyrotechnic or other stored energy mechanisms, 2) that remotely deploys light of an adherent nature capable of adhering to and moving with a target 3) deploys visible/non-visible light with limited in flight detection, and 4) prevents firing forces from mixing chemiluminescent materials, thereby reducing the loss of the most intense portion of light production which occurs early in the reaction cycle.
Therefore, what is needed is a training projectile that safely provides day and night visibility which is initiated upon impact with a target. While the projectile may be used for short range, a need exits for a long range, long-flight time projectile that prevents light production resulting from setback or firing forces, thus providing the majority of the chemical light reaction to occur as the munition impacts the target area and releases its signal.

SUMMARY OF THE INVENTION

The present invention relates to a non-pyrotechnic, self-illuminating projectile useful for marking, target illumination, or targeting adjustment which produces chemiluminescent light upon impact with an object. Because the production of light is delayed until impact, the projectile is not visualized until impact and the intensity of light upon impact is greater than those projectiles that provide intermixing of light generating chemicals upon a firing force or during flight.

The term “chemiluminescent reactant components” as used herein is interpreted to mean a mixture of components, such as the oxalate or activator, or individual components, such as oxalic acid ester, and a fluororescer, which when intermixed produces a chemiluminescent reaction. While the two component system typically requires the “oxalate” component and the “activator” component to be separated, separation may occur within a single frangible container or using several frangible containers containing various reactants. In either case, rupture of the containers causes intermixing and results in light production.

In a particular embodiment, the light emitting projectile for marking a target upon impact comprises a projectile body having a first end, a second end, a plurality of side walls, a base plate, and an interior portion therein. The inner portion includes chemiluminescent reactant components contained within a plurality of frangible containers which are exemplified as, albeit not limited to, ampoules. At least one chemiluminescent reaction activator element is releasably attached to the base plate. Impact of the projectile with a target produces sufficient force to release the chemiluminescent reaction activator element within the inner channel. As the chemiluminescent reaction activator element moves within the inner channel, it contacts the ampoules. Contact of the ampoules results in releasing and intermixing of the chemiluminescent reactant components, resulting in the generation of light.

In an alternative embodiment, the light emitting projectile for marking a target upon impact comprises a projectile body having a first end, a second end, a plurality of side walls, a base plate, and an interior portion therein. The inner portion includes chemiluminescent reactant components contained within one or more chambers separated by membranes. At least one chemiluminescent reaction activator element is releasably attached to the base plate. Impact of the projectile with a target produces sufficient force to release the chemiluminescent reaction activator element from the base plate. Chemiluminescent light is produced by penetration of the membranes by the chemiluminescent reaction activator element, which results in intermixing of the chemiluminescent reactant components.

A unique aspect of the instant invention therefore, is the use of an inertial mass, such as a chemiluminescent reaction activator element which is secured in such a fashion so as to be released only upon final impact of the device resulting from failure of the securing structure or mechanism. Release of chemiluminescent reaction activator element controllably ruptures the ampoules or membranes containing chemiluminescent reagents, causing the intermixing of the chemiluminescent reagents and the production of light. The effect of this type of design results in the initiation of the chemiluminescent light production being delayed until impact. The advantage of such a projectile is in providing a projectile that can not be visualized until impact and provides intense light production at the point of impact as compared to diminished light intensity during flight time as is the case with setback force activated devices.

The instant invention allows illumination to occur either entirely within the confines of the projectile or to be dispersed upon impact. By eliminating any pyrotechnics from the projectile, the likelihood of collateral damage or indirect injury is virtually eliminated. By delaying the intermixing of the chemiluminescent reagents until impact, the projectile allows use of highly catalyzed reactions with relatively short durations and prevents the most intense portion of the reaction cycle from being wasted during flight. By providing for the use of non-visible chemiluminescent reagents with or without additional marking materials, the instant invention lends itself to stealthy tactical or training applications.

A further advantage of using a secured inertial mass design in contrast to a free moving inertial mass design is that the projectile can readily withstand routine testing, such as drop tests, typically applicable to munitions. Impulse forces realized during such testing can be readily calculated and the strength of the securing force required can be derived. In this manner the minimum strength required to survive such tests may be calculated and used in the construction of a final product having securing forces conveniently above those of the test requirements while simultaneously well below those encountered in actual deployment. In this way, one skilled in the art with comprehensive knowledge of material properties could tailor the secured mass design to optimally suit numerous projectile applications functioning over a wide range of velocities and impact forces.

Accordingly, it is a primary objective of the instant invention to provide a chemiluminescent projectile which provides a mechanism for controlling light activation until impact upon a target.

It is a further objective of the instant invention to provide a chemiluminescent projectile which utilizes a secured, releasable inertial mass for controlling light activation until impact upon a target.

It is a further objective of the instant invention to provide a chemiluminescent projectile which provides illumination to occur within the projectile.

It is yet another objective of the instant invention to provide a chemiluminescent projectile which provides dispersion of illumination upon impact with a target.

It is a still further objective of the invention to provide a chemiluminescent projectile which reduces the likelihood of collateral damage or indirect injury by eliminating the use of pyrotechnics.

It is a further objective of the instant invention to provide a chemiluminescent projectile which provides delayed intermixing of chemiluminescent reactant components until impact.

It is yet another objective of the instant invention to provide a chemiluminescent projectile which provides for use of highly catalyzed reactions with relatively short durations.
It is a still further objective of the invention to provide a long range, long-flight time chemiluminescent projectile which prevents light production resulting from set-back or firing forces, thus providing the majority of the chemical light reaction to occur as the projectile impacts the target area and releases its contents.

It is a further objective of the invention to provide a chemiluminescent projectile which prevents firing forces from mixing chemiluminescent materials, thereby reducing the loss of the most intense portion of light production which occurs early in the reaction cycle.

It is yet another objective of the instant invention to provide a chemiluminescent projectile which provides stealthy tactical and training applications.

It is still further object of this invention to provide a chemiluminescent projectile which produces light visible to the human eye.

Another objective of this invention is to provide a chemiluminescent projectile which produces infrared or ultraviolet light.

Other objectives and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings wherein are set forth, by way of illustration and example, certain embodiments of this invention. The drawings constitute a part of this specification and include exemplary embodiments of the present invention and illustrate various objectives and features thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the chemiluminescent projectile.

FIG. 2 is a cross-sectional view of the chemiluminescent projectile taken along line A of FIG. 1.

FIG. 3 is a cross-sectional view of the chemiluminescent projectile taken along line B of FIG. 1A.

FIG. 4 illustrates a cross-sectional view of the chemiluminescent projectile illustrating use of pins for securing the chemiluminescent reactant activator element.

FIG. 5 illustrates a cross-sectional view of the chemiluminescent projectile illustrating use of thread for securing the chemiluminescent reactant activator element.

FIG. 6 illustrates a cross-sectional view of the chemiluminescent projectile illustrating use of magnets for securing the chemiluminescent reactant activator element.

FIG. 7 illustrates an alternative embodiment of the chemiluminescent projectile prior to impact with a target.

FIGS. 8A-8E illustrate various connecting methods for connection of membranes to the chemiluminescent projectile.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1-3, illustrated is a projectile having a first leading end 2, referring generally to the end that makes contact with a target, and a second trailing end 3. The body of projectile 1 is further defined by side walls 4 and 5. A base plate 6 seamlessly engages the projectile body adjacent to the second end 3, thus forming an inner portion 7. Although the figure illustrates a generally cylindrical shape body having a rounded front end, any shape is within the scope of the invention. Located within inner portion 7 is a plurality of ampoules 8 made of rupturable materials, such as glass or plastic, and which contain chemiluminescent reactant components.

Typical chemical light systems employ various chemiluminescent reactant components, including an oxalate ester, hydrogen peroxide, a fluorescer, and a catalyst. In its most basic form the two-component, liquid phase oxalate ester chemical light system must comprise an “oxalate component” comprising an oxalic acid ester and a solvent, and a “peroxide component” comprising hydrogen peroxide and a solvent or mixture of solvents. In addition, an efficient fluorescer must be contained in one of the components. An efficient catalyst, necessary for maximizing intensity and lifetime control, may be contained in one of the components. In typical use, the chemiluminescent reactant components are divided until time of use by placing the oxalate ester and dye in one solution and hydrogen peroxide and catalyst in a second solution. To generate light, the two solutions are intermixed. The instant invention takes advantage of this system by placement of chemiluminescent reactant components, or combinations thereof, within the plurality of ampoules 8 to produce light in various spectrums, including visible light at different wavelengths, infrared light, and ultraviolet light.

Oxalates useful in the present invention include but are not limited to bis(2,4,5-trichloro-6-carbopentoxycarbonyl)oxalate; bis(2,4,5-trichlorophenyl)oxalate; bis(2,4,5-trichloro-6-carbopenta-4-oxyphenyl)oxalate; bis(2-nitrophenyl)oxalate; bis(2,4-dinitrophenyl)oxalate; bis(2,6-dichloro-4-nitrophenyl)oxalate; bis(2,4,6-trichlorophenyl)oxalate; bis(2,4-dinitro-6-phenylethynyl)oxalate; bis(2,4-dichloro-6-phenylethynyl)oxalate; bis(2,4-dinitro-6-phenyl)oxalate; bis(2,4-dinitro-6-methyl)oxalate; bis(2,4-dichloro-6-methyl)oxalate; bis(2,4-dinitro-phenyl)oxalate; bis(2,4-dinitro-phenyl)oxalate; bis(2,4-dinitro-phenyl)oxalate; bis(2,4-dihydro-2-oxo-1-pyridyl)glyoxal; bis(2,4-dinitro-6-methylphenyl)oxalate; and bis-N-phthalimidyl oxalate.

Oxalate solvents useful in the present invention include but are not limited to a propylene glycol dialkyl ether containing one to three propylene moieties and each alkyl group is independently a straight-chain or branched-chain alkyl group containing up to 8 carbon atoms. Especially preferred first solvents are propylene glycol dialkyl ethers containing two propylene moieties such as dipropylene glycol dimethyl ether, dipropylene glycol diethyl ether and dipropylene glycol di-i-butyl ether. The particularly preferred first solvent comprises dipropylene glycol dimethyl ether, dibutyl phthalate, butyl benzoate, propylene glycol dibenzoate, and ethyl-hexyl diphenyl phosphate.

Peroxides useful in the present invention include but are not limited to hydrogen peroxide; sodium peroxide; sodium perborate; sodium pyrophosphate peroxide; urea peroxide;

histidine peroxide; t-butyl-hydroperoxide; and peroxybenzoic acid.

Activator solvents useful in the present invention include, but are not limited, to dimethyl phthalate, triethyl citrate, and ethylene glycol dibenzoate.

Fluorescers useful in the present invention include but are not limited to 1-methoxy-9,10-bis(phenylethynyl)anthracene, perylene, rubrene, 16,17-didecyloxyviolanthrone, 2-ethyl-9,10-bis(phenylethynyl)anthracene, 2-chloro-9,10-bis(4-ethoxyphenyl)anthracene, 2-chloro-9,10-bis(4-methoxyphenyl)anthracene, 9,10-bis(phenylethynyl)
anthracene; 1-chloro-9,10-bis(phenylethynyl)anthracene; 1,8-dichloro-9,10-bis(phenylethynyl)anthracene; 1,5-dichloro-9,10-bis(phenylethynyl)anthracene; 2,3-dichloro-9,10-bis(phenylethynyl)anthracene; 5,12-bis(phenylethynyl)tetracene; 9,10-diphenylanthracene; 1,6,7,12-tetraphenoxy-n,N'-bis(2,6-diisopropylphenyl)-3,4,9,10-pyrene dicarboximide; 1,6,7,12-tetraphenoxyn-N,N'-bis(5-di-t-butylyphenyl)-3,4,9,10-pyrene dicarboximide; 1,7-di-chloro-6,12-diphenoxy-N,N'-bis(2,6-diisopropylphenyl)-3,4,9,10-pyrene dicarboximide; 1,6,7,12-tetraphenoxyn-N,N'-di-neopentyl-1,3,4,9,10-pyrene dicarboximide; 1,6,7,12-teta(p-bromophenoxy)-N,N'-bis(2,6-diisopropylphenyl)-3,4,9,10-pyrene dicarboximide; 1,6,7,12-tetra(o-fluorophenoxy)-N,N'-bis(6-diisopropylphenyl)-3,4,9,10-pyrene dicarboximide; 1,6,7,12-tetra(p-fluorophenoxy)-N,N'-bis(2,6-diisopropylphenyl)-3,10,10-pyrene dicarboximide; 1,6,7,12-dibromo-6,12-diphenoxy-N,N'-bis(2-isopropylphenyl)-3,4,9,10-pyrene dicarboximide; 16,17-dihexyloxyviolanthrone; rubrene; and 1,4,4-dimethyl-9,10-bis(phenylethynyl)anthracene.

Chemiluminescent reaction activator element 11 has a body portion 12 and a triangularly shaped front portion 13 having a blunt end (see for example FIG. 2) or a sharp, pointed end (see for example FIG. 7). In the non-impacted state, body portion 12 attaches to base plate 6. In this manner, front portion 13 of chemiluminescent reaction activator element 11 is directed toward front portion 2 of projectile 1. Chemiluminescent reaction activator element 11 is secured to base plate 6 by various mechanical and/or physical mechanisms known to one of skill in the art. For example, chemiluminescent reaction activator element 11 can be designed as an integral part of the base plate or can be interconnected by frictional forces or press fitting. FIG. 4 illustrates the use of one or more pins which attach to either side wall 4 or a portion of the holding element. The pin extends into the chemiluminescent reaction activator element, see pin 14, or extends through the chemiluminescent reaction activator element, attaching to side wall 5 or the opposite portion of the holding element, see pin 15. FIG. 4 illustrates a particular embodiment utilizing threading. Chemiluminescent reaction activator element contains threading 16 and is designed to fit into threading receiving area 17 construed within the holding element. Both the pins and the threading are designed to dislodge or break apart upon impact of the projectile to allow release of the chemiluminescent reaction activator element 11 and movement within the channel 10 upon an impact force. FIG. 5 illustrates the use of magnetic bonding as a securing mechanism. In this embodiment, magnet 18 and/or 19 is positioned near the chemiluminescent reaction activator element 11. To aid in the magnetic bonding, chemiluminescent reaction activator element 11 is made of, or coated with, a magnetic material. Additional embodiments include the use of magnets or magnetic materials within the base plate as well. Finally, an alternative securing method includes the use of adhesives placed on the chemiluminescent reaction activator element 11, base plate 6, or combinations thereof. The strength of the bonding is designed such that impact forces results in release of the chemiluminescent reaction activator element 11.

In practice, projectile 1 is utilized as large or small caliber munitions or as a component of a bullet cartridge containing the projectile, in various large or small calibers, a propellant, i.e. gunpowder, and a primer. Either the individual projectiles or the bullet cartridge can then be loaded into a weapon, and fired. In use, as the projectile is fired from the weapon and subject to the initial firing force, chemiluminescent reaction activator element 11 remains connected to base plate 6. Because chemiluminescent reaction activator element 11 remains connected, the contents of ampoules 8 do not intermix and the projectile cannot produce chemiluminescent light upon either firing or during flight. However, as the projectile travels along a trajectory and contacts a target, the force of impact releases chemiluminescent reaction activator element 11 from base plate 6, causing chemiluminescent reaction activator element 11 to move within inner channel 10 in a direction towards the direction of travel, i.e. towards first end 2. As chemiluminescent reaction activator element 11 moves, the front portion 13 of the chemiluminescent reaction activator element 11 contacts ampoules 8 which causes rupture of the ampoules. As the ampoules rupture, the contents contained within are released, causing intermixing of the chemiluminescent reactant components and light production. Since the object of this type of device is to produce usable light output, the projectile is usually composed of a clear or
translucent material, such as polyethylene or polypropylene, which permits the light produced by the chemiluminescent system to be transmitted through the projectile walls. Additionally, the projectile may be constructed of materials which are biodegradable and/or inert.

The effect of this type of design results in the initiation of the chemiluminescent light production being delayed until impact. While the projectile cannot be visualized until impact, the design of the projectile provides intense light production at the point of impact as compared to diminished light intensity for those projectiles in which light is produced during flight time as seen with setback force activated devices.

In addition to the chemiluminescent components, marker material 22, such as fluorescent marker powder, dyes including but not limited to water soluble dyes such as Brown HT; Quinoline Yellow; Indigo Carmine; Brilliant Blue FCF; Ponceau 4R; Sunset Yellow; Indigotine; Fast Green FCF; Alura Red AC; and inert filler 23, such as but not limited to marble dust (calcium carbonate), granulated or powdered PVC resin with or without additional dyes, glass beads, sand, plastic resin pellets, or the like, are contained within the inner portion 7. The marker material and/or filler materials can be separated from the holding element 9 and compartmentalized within the inner portion by use of one or more membranes, 20 and 21, which form one or more chambers 24 and 25.

Depending on the construction of the projectile, illumination can occur entirely within the confines of the device or be dispersed upon impact. If the device is made of non-frangible materials, light production can be maintained within the device. In addition, the projectile can be constructed such that any light produced can be visualized over the entire projectile or limited to a portion of the projectile body. For example, light production can be limited to a defined portion by utilizing one or more membranes, 20 and 21 which separate holding element 9 from the rest of the inner portion of the projectile, thus creating separate compartments. Membrane 20 can be constructed of a material that is not punctured or penetrated by the chemiluminescent reaction activator element 11 as it is released from the base plate, thereby limiting any chemiluminescent light produced to that area. In an alternative embodiment, the holding element may be made of a permeable material that absorbs the liquids released from the ampoules, thus trapping them to a confined area.

The inner portion of the projectile may also be filled with optional marking dye 22, inert filler 23 capable of absorbing the chemiluminescent reagents and further contributing the overall mass of the projectile, or a mix of filler and marker dye. Dispersal of the projectile contents to a target may be accomplished by constructing the projectile from a fungible material. As the projectile impacts a target, the fungible materials fail, resulting in release of the projectile’s contents. Apertures 27 within the side walls or other parts of the projectile provide an alternative method of providing dispersal of chemiluminescent light to a target. Moreover, as chemiluminescent reaction activator element 11 is released and travels through the inner channel, it can act as a piston to disperse the chemiluminescent reactant components through such apertures.

FIG. 7 illustrates an alternative illustrative embodiment of the chemiluminescent projectile. Similar to the previous embodiments, projectile 201 includes a first leading end 202, a second trailing end 203, and side walls 204 and 205. A base plate 206 sealingly engages the projectile body adjacent to the second end 203, thus forming an inner portion 207. Inner portion 207 contains chemiluminescent reaction activator element 211 which attaches to base plate 206. Side walls 204 and 205 may be continuous or, as illustrated, designed as multicomponents having a first member portion 208 adjoining a second member portion 209. Interconnection of first member portion 208 and a second member portion 209 may be accomplished by various mechanisms known to one of skill in the art, such as by press-fitting or use of threading. Chemiluminescent reaction activator element 211 is prevented from rearward and/or lateral movements movement by attachment to base 206, and optionally use of a membrane or shield 212, or other mechanisms, i.e. pins, magnets, as described previously. The second member portion 209 may contain marker dye 213, inert filler 214, or some combination of the two materials. First member portion 208 is further divided by one or more rupturable membranes 215, 216, and 217 that form inner compartment 218 and 219. Compartments 218 and 219 contain the chemiluminescent reactant components.

Membranes may be comprised of any suitable materials, such as aluminum foil or polyethylene and can be attached to the projectile by coating with a heat-sealable polymer varnish intended to adhere through application of heat to the body of the projectile. The heat-sealable polymer varnish is preferably non-reactive with any of the chemiluminescent components and will not affect the production of light if contacted with the chemiluminescent components. FIGS. 8A-8E represents illustrative embodiments of membrane attachment methods. One or more membranes 215, 216, or 217 can be attached to the projectile via heat sealing directly to shoulders 220 formed within the side walls 204 and 205, see FIG. 8A, to a cylindrical element 221 with shoulders 222, see FIG. 8B, or without shoulders 222, see FIG. 8C, or through use of seals or flanges 223 molded into the projectile body, see FIG. 8D. FIG. 8E illustrates sealing of membrane 215 directly into the side walls 204 and 205.

Upon impact with the target, chemiluminescent reaction activator element 211 is released from the base plate 206, resulting in motion toward first leading end 202. Chemiluminescent reaction activator element 211 is made of a material strong enough to puncture the membranes, thus allowing intermixing of the chemiluminescent reactant components, marker materials, inert filler, or combinations thereof. The configuration of the chemiluminescent reaction activator element 211 can be adjusted for different desired functionality. For example, a larger diameter chemiluminescent reaction activator element could act as a piston and forcibly move the chemiluminescent reagent mixture forward where it could then be expelled through one or more apertures (not illustrated) located within the perimeter of the projectile.

It is to be understood that while a certain form of the invention is illustrated, it is not to be limited to the specific form or arrangement herein described and shown. It will be apparent to those skilled in the art that various changes may be made without departing from the scope of the invention and the invention is not to be considered limited to what is shown and described in the specification and drawings/figures.

One skilled in the art will readily appreciate that the present invention is well adapted to carry out the objectives and obtain the ends and advantages mentioned, as well as those inherent therein. The embodiments, methods, proce-
dure and techniques described herein are presently representative of the preferred embodiments, are intended to be exemplary and are not intended as limitations on the scope. Changes therein and other uses will occur to those skilled in the art which are encompassed within the spirit of the invention and are defined by the scope of the appended claims. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as claimed should not be unduly limited to such specific embodiments. Indeed, various modifications of the described modes for carrying out the invention which are obvious to those skilled in the art are intended to be within the scope of the following claims.

What is claimed is:

1. A light emitting projectile for marking a target upon impact comprising:
   a projectile body having a first end, a second end, side walls, and an interior portion therein;
   chemiluminescent reactant components;
   a base plate constructed to sealingly engage said projectile body adjacent said second end; and
   at least one chemiluminescent reaction activator element releasably attached to said base plate, wherein impact of said projectile with a target produces a force sufficient to release said chemiluminescent reaction activator element, said release of said chemiluminescent reaction activator element resulting in the intermixing of said chemiluminescent reactant components and the generation of light.

2. The light emitting projectile for marking a target upon impact according to claim 1 wherein said chemiluminescent reactant components are housed within at least one frangible container.

3. The light emitting projectile for marking a target upon impact according to claim 2 wherein at least a portion of said at least one frangible container is secured by a holding element.

4. The light emitting projectile for marking a target upon impact according to claim 3 wherein said holding element further includes a longitudinally extending inner channel.

5. The light emitting projectile for marking a target upon impact according to claim 4 wherein a portion of said at least one ampoule is exposed to said inner channel.

6. The light emitting projectile for marking a target upon impact according to claim 5 wherein said chemiluminescent reaction activator element is constructed and arranged to move within said inner channel.

7. The light emitting projectile for marking a target upon impact according to claim 6 further including filler material, marking material, or combinations thereof.

8. The light emitting projectile for marking a target upon impact according to claim 7 further including at least one membrane separating said holding element and said filler material, marking material, or combinations thereof.

9. The light emitting projectile for marking a target upon impact according to claim 6 wherein said projectile is frangible.

10. The light emitting projectile for marking a target upon impact according to claim 6 wherein said projectile is non-frangible.

11. The light emitting projectile for marking a target upon impact according to claim 6 wherein said chemiluminescent reactant components produce visible light.

12. The light emitting projectile for marking a target upon impact according to claim 6 wherein said chemiluminescent reactant components produce infrared light.

13. The light emitting projectile for marking a target upon impact according to claim 6 wherein said chemiluminescent reactant components produce ultraviolet light.

14. The light emitting projectile for marking a target upon impact according to claim 6 wherein said projectile is made from biodegradable material.

15. The light emitting projectile for marking a target upon impact according to claim 6 further containing one or more apertures for expulsion of said intermixed chemiluminescent components to a target area.

16. The light emitting projectile for marking a target upon impact according to claim 1 wherein said chemiluminescent reactant components are housed within at least one chamber separated by at least one or more membranes.

17. The light emitting projectile for marking a target upon impact according to claim 16 wherein said side walls contain a first member adjoining a second member.

18. The light emitting projectile for marking a target upon impact according to claim 16 wherein said chemiluminescent reactant components produce visible light.

19. The light emitting projectile for marking a target upon impact according to claim 16 wherein said chemiluminescent reactant components produce infrared light.

20. The light emitting projectile for marking a target upon impact according to claim 16 wherein said chemiluminescent reactant components produce ultraviolet light.

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