

THERMAL SIGNALING OR MARKING DEVICE

[001] The present application claims priority to U.S. Provisional Patent Application No. 61/343,469, filed April 28, 2010, which is incorporated herein by reference.

[002] The present disclosure relates to the field of portable, self-contained thermal signaling or marking devices and in particular, thermal signaling or marking devices that derive their energy from a controlled chemical reaction which is not pyrotechnic in nature.

[003] There are many situations where a reliable heat source is required in which it is not possible or practical to employ electricity or flammable fuels. For example, a camper may wish to have a hot meal or beverage but may not be close to a source of electricity to power a resistance-type heating device or microwave oven. The surrounding environment, for example a petroleum tank farm, may prohibit the use of burning fuels such as charcoal or stove fuel. In these situations a non-electric, non-pyrotechnic heating system would be desired. A variety of such systems have been developed which because of their nature do not require a source of electricity and are not a source of ignition. Examples of these systems may be found in the prior art and have been variously employed as hand warmers, food and beverage heaters and therapeutic heaters.

[004] Another application for a non-electric, non-pyrotechnic heating device is as a signaling device. Law enforcement and military personnel often employ thermal imaging equipment to observe individuals and other objects covertly. This thermal imaging equipment is able to discern very small differences in the apparent temperature of objects. A person hiding in a field of thick brush may not be visible to the naked eye, particularly at night when there is little or no light. A thermal imaging device, however, will be able to detect the difference in the temperature of the brush as compared to the temperature of the individual's skin or the clothing the individual is wearing. A "heat image" of the individual is then displayed which makes the individual highly visible.

[005] With the increased use of thermal imaging equipment, there is also a parallel need for improved thermal sources. For example, it may be desirable to

mark a trail or a turn in the road in a manner that can only be seen by those with thermal imagers. A potential target might be marked with a thermal "beacon" so that it can be seen by others using thermal imagers. In a combat situation, a soldier may want to covertly signal allies who are using thermal imaging equipment by marking the soldier's location with a thermal beacon so that the soldier may be rescued or at least be identified as a "friendly."

[006] While a variety of devices have been developed for the purpose previously described, there is still a need for a heat generating device which has many, if not all, of the following characteristics: low-cost, reliable, compact, safe, easy to deploy, highly efficient, not a source of ignition, non-toxic, bio-degradable, and environmentally friendly.

[007] It is accordingly an object of the disclosure to provide a multiple-part electrochemical thermal signaling or marking system comprising at least one first part comprising at least one super-corroding alloy and at least one absorbent material, and at least one second part. The at least one first part and the at least one second part must be kept separate until use, at which time they are combined and heat generation commences.

[008] In another aspect of the present disclosure, a method of water or aqueous moisture detection is provided wherein a multiple-part electrochemical thermal signaling or marking system comprising at least one first part comprising at least one super-corroding alloy and at least one absorbent material, and at least one second part is deployed over an area of interest. In some embodiments, thermal energy is emitted upon deployment due to the presence of water or aqueous moisture in the area of interest. In other embodiments, thermal energy is emitted at a time after deployment when water or aqueous moisture enters the area of interest.

[009] In a further embodiment, the dry components of the thermal signaling or marking system can be mixed and deployed over an area of interest. As above, thermal energy is emitted in certain embodiments upon deployment due to the presence of water or aqueous moisture in the area of interest. In other embodiments, thermal energy is emitted at a time after deployment when water or aqueous moisture enters the area of interest.

[010] In another aspect of the present disclosure, at least one of the parts may be contained inside a housing which keeps the at least one first part of the

multi-part electrochemical thermal signaling or marking system separate from the at least one second part, until such time as mixing is desired.

[011] In a further embodiment, the present disclosure is directed to a containment device comprising at least one first containment part, at least one second containment part, at least one vent member in fluid communication with the outside of the containment device and at least one of the at least one first containment member and the at least one second containment member, and at least one breakable barrier separating the at least one first containment part from the at least one second containment part.

[012] In yet another embodiment, the present disclosure is directed to a containment device comprising at least one first member comprising a sealable opening, at least one second member bound to the at least one first member to provide at least one space between the at least one first member and the at least one second member wherein the at least one space comprises at least one super-corroding alloy and at least one absorbent material. The opening is in fluid communication with the at least one space and the outside of the containment device through which one of water, an aqueous solution, an electrolyte, or mixtures of any of the foregoing may be introduced into the at least one space at which time heat generation commences.

[013] In a further embodiment, the present disclosure is directed to a containment device comprising at least one first containment part comprising at least one super-corroding alloy and at least one absorbent material, at least one breakable containment part disposed within the at least one first containment part, and at least one vent member in fluid communication with the at least one first containment member and the outside of the containment device. The parts of the electrochemical thermal signaling or marking system disclosed in the present disclosure are contemplated to be contained in such housing and/or containment devices.

[014] Additional objects and advantages of the disclosure will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the disclosure. The objects and advantages of the present disclosure will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

[015] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

[016] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the description, serve to explain the principles of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[017] **FIG. 1** depicts a device for producing non-electric, non-pyrotechnic heat.

[018] **FIG. 2** depicts an exploded view of a device for producing non-electric, non-pyrotechnic heat.

[019] **FIG. 3** depicts an exploded view of another device for producing non-electric, non-pyrotechnic heat.

[020] **FIG. 4** depicts another device for producing non-electric, non-pyrotechnic heat.

[021] **FIG. 5** depicts yet another device for producing non-electric, non-pyrotechnic heat.

[022] **FIG. 6** depicts a further device for producing non-electric, non-pyrotechnic heat.

DESCRIPTION OF THE EMBODIMENTS

[023] The heating devices and systems according to the present disclosure derive their energy from a controlled chemical reaction which is not pyrotechnic in nature. As used herein, the term "pyrotechnic" refers to any process whereby a fuel undergoes rapid oxidation such as in the burning or catalytic decomposition of a fuel with an oxidizer. The term is also defined to include non-oxidizing reactions such as those between dissimilar metals or other materials known as "thermites" or materials which undergo "gasless" combustion. The term does not include galvanic reactions.

[024] As used herein, the term "non-electric" refers to devices and systems that do not utilize electricity outside of the electric generating system itself. The term does not include galvanic reactions.

[025] An embodiment of the present disclosure is directed to a multi-part electrochemical thermal signaling or marking system comprising at least one first

part comprising at least one super-corroding alloy and at least one absorbent material, and at least one second part comprising at least one component. In certain embodiments, the at least one second part comprises a component chosen from water, an aqueous solution, at least one electrolyte, and mixtures of any of the foregoing. As used herein, the term "aqueous solution" refers to a solution comprising water and at least one additional substance, which may be a solid, a liquid, a gas, or a combination of any of the foregoing. Also as used herein, the term "electrolyte" refers to any chemical compound that ionizes when dissolved or molten to produce an electrically conductive medium.

[026] In accordance with the present disclosure, the at least one absorbent material can be chosen from, for example, natural and synthetic polymeric absorbents, hydrocolloid/polysaccharide absorbents, cellulosic absorbents, gum and resin absorbents, inorganic absorbents, gel-forming fluid-interactive adhesive dressings, wool, cotton, lint, at least one super-absorbent polymer, and mixtures of any of the foregoing.

[027] In certain embodiments, the at least one absorbent material comprises at least one super-absorbent polymer. Examples of the at least one super-absorbent polymer useful in the present disclosure include, for example, solid water-swallowable, water-insoluble polymeric sorbents which are lightly cross-linked polymers, such as polyvinylpyrrolidones, sulfonated polystyrenes, sulfonated polyvinyltoluenes, poly-sulfoethyl acrylates, poly-2-hydroxyethyl acrylates, polyacrylates, hydrolyzed polyacrylamides and copolymers of acrylamide with acrylic acid described in U.S. Patent No. 3,669,103, hydrocolloid absorbent material described in U.S. Patent No. 3,670,731, sodium polyacrylate, potassium polyacrylate, lithium polyacrylate, ammonium polyacrylate, and mixtures of any of the foregoing. In certain embodiments, the at least one super-absorbent polymer comprises sodium polyacrylate. A suitable super-absorbent polymer for this purpose is produced by Emerging Technologies, Inc., Greensboro, North Carolina, currently sold under the trade name 2G-70.

[028] In some embodiments in accordance with the present disclosure, at least a portion of the at least one super-absorbent polymer comprises a coating. In other embodiments, a substantial amount of the super-absorbent polymer comprises a coating. As used herein, the term "substantial amount" refers to an amount greater than about 50% of the total amount. Non-limiting examples include an amount

greater than 60% of the total amount, an amount greater than 70% of the total amount, an amount greater than 75% of the total amount, an amount greater than 80% of the total amount, an amount greater than 90% of the total amount, and an amount greater than 95% of the total amount. Examples of coating materials useful in the present disclosure include coatings comprising at least one hydrophobic component. In certain embodiments, the at least one hydrophobic component is chosen from water insoluble thermoplastic organic materials including hydrocarbons and naturally occurring resins from petroleum, asphalt and coal tar; organic silicon compounds including polyorganosiloxanes, polysiloxanes containing halogens including fluorine, halohydrocarbons, including polymers containing chlorine and fluorine; various polymers in the form of natural or synthetic emulsions; hydrophobic pyrogenic silica; and mixtures of any of the foregoing. In certain other embodiments, the hydrophobic component comprises pyrogenic silica. A suitable pyrogenic silica for this purpose is produced by Wacker Chemical Corporation, Adrian, Michigan, currently sold under the trade name HDK® H15.

[029] In certain embodiments, the at least one super-absorbent polymer is present in an amount ranging from about 0.5 percent to about 90 percent by weight, based on the dry weight of the at least one first part. For example, the at least one super-absorbent polymer can be present in an amount ranging from about 0.5 percent to about 80 percent by weight, based on the dry weight of the at least one first part, such as from about 0.5 percent to about 75 percent by weight, from about 0.5 percent to about 70 percent by weight, from about 0.5 percent to about 65 percent by weight, from about 0.5 percent to about 60 percent by weight, about 0.5 percent to about 55 percent by weight, from about 0.5 percent to about 50 percent by weight, from about 0.5 percent to about 45 percent by weight, from about 0.5 percent to about 40 percent by weight, about 0.5 percent to about 35 percent by weight, from about 0.5 percent to about 30 percent by weight, from about 0.5 percent to about 25 percent by weight, from about 0.5 percent to about 20 percent by weight, from about 1 percent to about 80 percent by weight, from about 1 percent to about 75 percent by weight, from about 1 percent to about 70 percent by weight, from about 1 percent to about 65 percent by weight, from about 1 percent to about 60 percent by weight, about 1 percent to about 55 percent by weight, from about 1 percent to about 50 percent by weight, from about 1 percent to about 45 percent by weight, from about 1 percent to about 40 percent by weight, from about 1 percent to about 35 percent by

weight, from about 1 percent to about 30 percent by weight, from about 1 percent to about 25 percent by weight, from about 1 percent to about 20 percent by weight, from about 2 percent to about 80 percent by weight, from about 2 percent to about 75 percent by weight, from about 2 percent to about 70 percent by weight, from about 2 percent to about 65 percent by weight, from about 2 percent to about 60 percent by weight, about 2 percent to about 55 percent by weight, from about 2 percent to about 50 percent by weight, from about 2 percent to about 45 percent by weight, from about 2 percent to about 40 percent by weight, from about 2 percent to about 35 percent by weight, from about 2 percent to about 30 percent by weight, from about 2 percent to about 25 percent by weight, from about 2 percent to about 20 percent by weight, from about 5 percent to about 80 percent by weight, from about 5 percent to about 75 percent by weight, from about 5 percent to about 70 percent by weight, from about 5 percent to about 65 percent by weight, from about 5 percent to about 60 percent by weight, about 5 percent to about 55 percent by weight, from about 5 percent to about 50 percent by weight, from about 5 percent to about 45 percent by weight, from about 5 percent to about 40 percent by weight, from about 5 percent to about 35 percent by weight, from about 5 percent to about 30 percent by weight, from about 5 percent to about 25 percent by weight, and from about 5 percent to about 20 percent by weight. In certain embodiments, the at least one super-absorbent polymer is present in an amount of about 1 percent, about 3 percent, about 5 percent, about 7 percent, about 10 percent, about 15 percent, about 20 percent, about 25 percent, about 30 percent, about 35 percent, about 40 percent, about 45 percent, about 50 percent by weight, about 55 percent, about 60 percent, about 65 percent, about 70 percent, about 75 percent, about 80 percent, about 85 percent, and about 90 percent by weight, based on the dry weight of the at least one first part. It is also intended that the amount of the at least one super-absorbent polymer can range between any of the numerical values listed above.

[030] The multi-part electrochemical thermal signaling or marking system of the present disclosure also comprises at least one super-corroding alloy. In certain embodiments, the at least one super-corroding alloy comprises at least one first alloy component chosen from aluminum, magnesium, zinc, and mixtures of any of the foregoing and at least one second alloy component chosen from iron, copper, nickel, titanium, chromium, carbon, and mixtures of any of the foregoing.

[031] For example, in certain embodiments, the at least one super-corroding alloy comprises magnesium and iron. A representative example of a suitable super-corroding alloy is an alloy with an atomic weight ratio of about 5% iron to about 95% magnesium, although other ratios may be suitably employed. A suitable alloy for this purpose is produced by Dymatron, Inc., Cincinnati, Ohio currently sold under the trade name C-5. The alloy, when reacted with a liquid electrolyte, such as salt water, can liberate a significant amount of heat. The reaction continues either until all of the at least one first alloy component has been consumed or the heat of the reaction has caused the water to evaporate, thereby removing the electrolyte from the system. Without wishing to be bound by any particular theory, the rate of consumption of the at least one super-corroding alloy can be modulated by varying the atomic weight ratio of the at least one second alloy component to the at least one first alloy component present such that varying the atomic weight percent of the at least one second alloy component prolongs the thermal output of the electrochemical thermal signaling or marking system by slowing the reaction rate.

[032] In some embodiments, the at least one first alloy component may be present in an atomic weight percent ranging from about 80 percent to about 99.5 percent and the at least one second alloy component may be present in an atomic weight percent ranging from about 0.5 percent to about 20 percent. For example, the at least one first alloy component may be present in an atomic weight percent ranging from about 80 percent to about 99 percent, such as from about 80 percent to about 98 percent, from about 80 percent to about 97 percent, from about 80 percent to about 96 percent, from about 80 percent to about 95 percent, from about 80 percent to about 93 percent, from about 82 percent to about 93 percent, from about 86 percent to about 93 percent, from about 88 percent to about 93 percent, and from about 90 percent to about 93 percent. In certain embodiments, the at least one first alloy component is present in an atomic weight percent of about 80 percent, about 82 percent, about 86 percent, about 88 percent, about 90 percent, about 93 percent, about 95 percent, about 97 percent, about 98 percent, about 99 percent, and about 99.5 percent. The at least one second alloy component, for example, can be present in an atomic weight percent ranging from 0.5 percent to 18 percent, such as from about 0.5 percent to about 14 percent, from about 0.5 percent to about 12 percent, from about 0.5 percent to about 10 percent, from about 1 percent to about 10

percent, from about 2 percent to about 10 percent, from about 3 percent to about 10 percent, from about 4 percent to about 10 percent, from about 5 percent to about 10 percent, and from about 7 percent to about 10 percent. In some embodiments, the at least one second alloy component is present in an atomic weight percent of about 0.5 percent, about 1 percent, about 2 percent, about 3 percent, about 4 percent, about 5 percent, about 7 percent, about 10 percent, about 12 percent, about 14 percent, about 18 percent, and about 20 percent. It is also intended that the atomic weight percent of the at least one first alloy component and the atomic weight percent of the at least one second alloy component can range between any of the numerical values listed above.

[033] Hydrogen gas can also be a product of the reaction described above. To account for the reactions that produce hydrogen gas, certain embodiments of the present disclosure provide a suitable venting means to relieve the hydrogen gas. According to these embodiments, it is possible to employ a plurality of vents in a manner so that regardless of device orientation, one vent will always be above the fluid level. In some embodiments, the venting means includes at least one vent which relieves hydrogen and retains the fluid. In other embodiments, the containment device comprises a porous material that allows hydrogen gas release while maintaining the fluid therein. In some embodiments, a substantial amount of the containment device comprises the porous material. In other embodiments, the containment device is itself made from the porous material. An example of a porous material useful in the present disclosure includes hydrophobic spun-bonded polyethylene, such as Tyvek[®] manufactured by DuPont.

[034] Without wishing to be bound by any particular theory, the thermal "life" of the electrochemical thermal signaling or marking system can depend on such aspects as the surface area of the reactive materials, electrolyte conductivity, and availability of water. One method for improving the duration of thermal output, is to delay reaction of some of the at least one super-corroding alloy. One method of accomplishing this delay is by coating particles of the at least one super-corroding alloy to prevent water access to the particles. In certain embodiments, the at least one super-corroding alloy comprises a mixture of particles comprising particles that are at least partially coated with a coating and particles that are substantially uncoated. As used herein, "partially coated" means that the particles comprise a

coating on at least 5 percent of the particle surface. "Substantially uncoated" as used herein indicates that the particles are uncoated on at least 95 percent of the surface of the particles. Without wishing to be bound by any particular theory, a coating can be used to slow the reaction between the super-corroding alloy and water or an aqueous solution in the presence of at least one electrolyte allowing for control of the thermal life span of the thermal signaling or marking system. In some embodiments, the at least one super-corroding alloy comprises particles chosen from uncoated particles, substantially uncoated particles, and at least partially coated particles and mixtures of any of the foregoing. In a further embodiment, the particles comprise a mixture of uncoated particles and at least partially coated particles.

[035] In certain embodiments, the quantity of substantially uncoated particles is greater than the quantity of at least partially coated particles. In certain other embodiments, the quantity of substantially uncoated particles is less than the quantity of at least partially coated particles. In yet another embodiment, the quantity of substantially uncoated particles is substantially the same as the quantity of at least partially coated particles. As used in this context, "substantially the same" means that the first value is within 1 percent of the second value. In other embodiments, particles are coated in aggregate thereby forming semi-rigid structures comprising the particles.

[036] In some embodiments, the coating comprises a water-soluble coating. In other embodiments, the coating comprises a water-permeable coating. In further embodiments, the coating comprises a water-degradable coating. In other embodiments, the coating comprises at least one ethoxylated long chain alcohol. A representative example of a suitable at least one ethoxylated long-chain alcohol comprises aliphatic alcohols of between 20 and 50 carbon atoms, although others may be suitably employed. Suitable ethoxylated long-chain alcohols for this purpose are produced by Baker Hughes, Sugar Land, Texas, currently sold under the trade name Unithox Ethoxylates, 700 series. In yet other embodiments, the coating comprising at least one ethoxylated long chain alcohol further comprises at least one water insoluble material. Suitable water insoluble materials include aliphatic alcohols of between 20 and 50 carbon atoms, although others may be suitably employed. In still other embodiments, the at least one super-corroding alloy comprises particles chosen from uncoated particles, substantially uncoated particles, and at least partially coated particles, and mixtures of any of the foregoing, and the coating is

chosen from a water-soluble coating, a water-permeable coating, a water-degradable coating, a coating comprising at least one ethoxylated long-chain alcohol, and mixtures of any of the foregoing.

[037] In some embodiments, coating of the at least one super-corroding alloy may be applied by "panning," "spray-coating," or similar processes. In other embodiments, a coating is applied by a process referred to as the "Wurster" process as described in U.S. Patent No. 3,196,827. In this process, the particles to be coated are maintained in a fluidized bed. The coating material is introduced as a fine spray that adheres to the particles. Process time and application rate determine overall coating thickness. The Wurster process is well-suited to coating small and irregular particles. Without wishing to be bound by any particular theory, coating materials may be applied in a non-aqueous form to avoid wetting the super-corroding alloy and initiating the reaction (even in the absence of salt) and thereby degrading the alloy.

[038] Without wishing to be bound by any particular theory, another method of delaying the reaction of some of the at least one super-corroding alloy is by varying the particle size of the at least one super-corroding alloy. The reaction tends to occur at the particle surface such that smaller particles tend to react at a higher reaction rate than larger particles. In accordance with one embodiment of the present disclosure, the at least one super-corroding alloy may comprise particles ranging in size from about U.S. Standard Sieve 14 to about U.S. Standard Sieve 200. In another embodiment, the at least one super-corroding alloy may comprise a mixture of particles comprising particles ranging in size from about U.S. Standard Sieve 16 to about U.S. Standard Sieve 20 and particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140. Additionally, in other embodiments, the quantity of particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140 is substantially the same as the quantity of particles ranging in size from about Standard Sieve 16 to about U.S. Standard Sieve 20. As used in this context, "substantially the same" means that the first value is within 1 percent of the second value. In still other embodiments, the at least one super-corroding alloy may comprise particles chosen from particles ranging in size from about U.S. Standard Sieve 14 to about U.S. Standard Sieve 200, particles ranging in size from about U.S. Standard Sieve 16 to about U.S. Standard Sieve 20,

particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140, and mixtures of any of the foregoing.

[039] In other embodiments, the quantity of particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140 is greater than the quantity of particles ranging in size from about U.S. Standard Sieve 16 to about U.S. Standard Sieve 20. And in still other embodiments, the quantity of particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140 is less than the quantity of particles ranging in size from about Standard Sieve 16 to about U.S. Standard Sieve 20.

[040] In some embodiments, the at least one super-corroding alloy comprises pellets formed from compressing particles of the least one super-corroding alloy. For example, such pellets can range in size from U.S. Standard Sieve 200 to pellets comprising a diameter of about 5 mm and a length of about 6 mm. Without wishing to be bound by any particular theory, the reaction of the at least one super-corroding alloy to produce thermal signaling or marking takes place at the surface of the pellet and slowly consumes the pellet. The geometries of the pellets, surface area (over which the reaction is occurring), and volume (or mass) can be selected to provide a desired reaction time in order to optimize the duration of thermal output. In certain embodiments, a pellet of at least one super-corroding alloy is produced by compressing particles of the at least one super-corroding alloy under a pressure of about 100,000 Kg/cm² (approx. 1.5 million PSI). The compressed pellets can form any desirable shape, and nonlimiting examples include, for example, shapes chosen from cylindrical, spherical, wedge, and star.

[041] The at least one super-corroding alloy described in the present disclosure may be present in an amount ranging from about 1 percent to about 99.5 percent by weight, based on the dry weight of the at least one first part. For example, the at least one super-corroding alloy can be present in an amount ranging from about 1 percent to about 90 percent by weight, based on the dry weight of the at least one first part, such as from about 1 percent to about 80 percent, from about 1 percent to about 75 percent by weight, from about 1 percent to about 70 percent by weight, from about 1 percent to about 60 percent by weight, from about 1 percent to about 50 percent by weight, from about 1 percent to about 40 percent by weight, from about 1 percent to about 30 percent by weight, from about 1 percent to about 25 percent by weight, from about 1 percent to about 20 percent by weight, from

about 3 percent to about 80 percent, from about 3 percent to about 75 percent by weight, from about 3 percent to about 70 percent by weight, from about 3 percent to about 60 percent by weight, from about 3 percent to about 50 percent by weight, from about 3 percent to about 40 percent by weight, from about 3 percent to about 30 percent by weight, from about 3 percent to about 25 percent by weight, from about 3 percent to about 20 percent by weight, from about 4 percent to about 75 percent by weight, from about 4 percent to about 70 percent by weight, from about 4 percent to about 60 percent by weight, from about 4 percent to about 50 percent by weight, from about 4 percent to about 40 percent by weight, from about 4 percent to about 30 percent by weight, from about 4 percent to about 25 percent by weight, from about 4 percent to about 20 percent by weight, from about 5 percent to about 75 percent by weight, from about 5 percent to about 70 percent by weight, from about 5 percent to about 65 percent by weight, from about 5 percent to about 60 percent by weight, from about 5 percent to about 50 percent by weight, from about 5 percent to about 40 percent by weight, from about 5 percent to about 30 percent by weight, from about 5 percent to about 25 percent by weight, from about 5 percent to about 20 percent by weight, from about 10 percent to about 65 percent by weight, from about 10 percent to about 60 percent by weight, from about 10 percent to about 50 percent by weight, from about 10 percent to about 40 percent by weight, from about 10 percent to about 30 percent by weight, from about 10 percent to about 25 percent by weight, and from about 10 percent to about 20 percent by weight. In other embodiments, the at least one super-corroding alloy is present in an amount of about 1 percent, about 4 percent, about 8 percent, about 10 percent, about 20 percent, about 25 percent, about 30 percent, about 35 percent, about 40 percent, about 45 percent, about 50 percent, about 55 percent, about 60 percent, about 65 percent, about 70 percent, about 75 percent, about 80 percent, about 85 percent, about 90 percent, about 95 percent, and about 99.5 percent by weight, based on the dry weight of the at least one first part. It is also intended that the amount of the at least one super-corroding alloy can range between any of the numerical values listed above.

[042] The multi-part electrochemical thermal signaling or marking system of the present disclosure further comprises a component of the at least one second part wherein the component is chosen from water, an aqueous solution, at least one electrolyte, and mixtures of any of the foregoing. In some embodiments, the

component is chosen from water and an aqueous solution, and the at least one first part further comprises at least one electrolyte. In other embodiments, the component comprises at least one electrolyte. In still other embodiments, the component comprises at least one electrolyte and at least one of water and an aqueous solution. As used herein, "aqueous solution" refers to a solution comprising water and at least one other material.

[043] In some embodiments, the at least one electrolyte comprises at least one salt comprising a cation chosen from Li^+ , Na^+ , K^+ , Mg^{2+} , Ca^{2+} , and combinations of any of the foregoing; and an anion chosen from Cl^- , Br^- , I^- , ClO_4^- , BF_4^- , PF_6^- , ASF_6^- , SbF_6^- , CH_3CO_2^- , CF_3SO_3^- , $\text{N}(\text{CF}_3\text{SO}_2)_2^-$, $\text{C}(\text{CF}_3\text{SO}_2)_2^-$, CO_3^{2-} , and combinations of any of the foregoing.

[044] In certain embodiments, the at least one electrolyte is present in an amount ranging from about 0.01 percent to about 36 percent by weight, based on the weight of the at least one second part. For example, the at least one electrolyte can be present in an amount ranging from about 0.01 percent to about 30 percent by weight, based on the weight of the at least one second part, such as from about 0.01 percent to about 25 percent, from about 0.01 percent to about 20 percent by weight, from about 0.01 percent to about 15 percent, from about 0.01 percent to about 10 percent by weight, from about 0.01 percent to about 5 percent, from about 0.01 percent to about 1 percent by weight, from about 0.1 percent to about 30 percent by weight, from about 0.1 percent to about 25 percent, from about 0.1 percent to about 20 percent by weight, from about 0.1 percent to about 15 percent, from about 0.1 percent to about 10 percent by weight, from about 0.1 percent to about 5 percent, from about 0.1 percent to about 1 percent by weight, from about 0.5 percent to about 30 percent by weight, based on the weight of the at least one second part, such as from about 0.5 percent to about 25 percent, from about 0.5 percent to about 20 percent by weight, from about 0.5 percent to about 15 percent, from about 0.5 percent to about 10 percent by weight, from about 0.5 percent to about 5 percent, from about 0.5 percent to about 1 percent by weight, from about 1 percent to about 30 percent by weight, from about 1 percent to about 25 percent, from about 1 percent to about 20 percent by weight, from about 1 percent to about 15 percent, from about 1 percent to about 10 percent by weight, from about 1 percent to about 5 percent, from about 4 percent to about 25 percent, from about 4 percent to about 20 percent by weight, from about 4 percent to about 15 percent, and from about 4

percent to about 10 percent by weight. In other embodiments, the at least one electrolyte is present in an amount of about 0.01 percent, 0.1 percent, 0.5 percent, 1 percent, about 2 percent, about 4 percent, about 6 percent, about 8 percent, about 10 percent, about 15 percent, about 20 percent, about 25 percent, about 30 percent, and about 36 percent by weight, based on the weight of the at least one second part. In yet another embodiment, the at least one electrolyte is present in an amount of about 4 percent by weight, based on the weight of the at least one second part. It is also intended that the amount of the at least one electrolyte can range between any of the numerical values listed above.

[045] In some embodiments, the at least one first part further comprises at least one hydrophobic component. In certain embodiments, the at least one hydrophobic component is chosen from water insoluble thermoplastic organic materials including hydrocarbons and naturally occurring resins from petroleum, asphalt and coal tar, organic silicon compounds including polyorganosiloxanes, polysiloxanes containing halogens including fluorine, halohydrocarbons, including polymers containing chlorine and fluorine, various polymers in the form of natural or synthetic emulsions, hydrophobic pyrogenic silica, and mixtures of any of the foregoing. In certain other embodiments, the hydrophobic component comprises pyrogenic silica. A suitable pyrogenic silica for this purpose is produced by Wacker Chemical Corporation, Adrian, Michigan, currently sold under the trade name HDK® H15.

[046] In some embodiments, the hydrophobic component is present in an amount ranging from about 0.1 percent to about 10 percent by weight, based on the dry weight of the at least one first part. For example, the at least one hydrophobic component can be present in an amount ranging from about 0.1 percent to about 9 percent by weight, based on the dry weight of the at least one first part, such as from about 0.1 percent to about 8 percent, from about 0.1 percent to about 6 percent by weight, from about 0.1 percent to about 4 percent by weight, from about 0.1 percent to about 2 percent by weight, from about 0.5 percent to about 8 percent by weight, from about 0.5 percent to about 6 percent by weight, from about 0.5 percent to about 4 percent by weight, from about 0.5 percent to about 2 percent by weight, from about 1 percent to about 6 percent by weight, from about 1 percent to about 4 percent by weight, from about 1 percent to about 2 percent by weight, from about 2 percent to about 6 percent by weight, and from about 2 percent to about 4 percent by weight.

In other embodiments, the at least one hydrophobic component is present in an amount of about 0.5 percent, about 1 percent, about 2 percent, about 4 percent, about 6 percent, about 8 percent, about 9 percent, and about 10 percent by weight, based on the dry weight of the at least one first part. In yet another embodiment, the at least one hydrophobic component is present in an amount of less than about 1 percent by weight, based on the dry weight of the at least one first part. It is also intended that the amount of the at least one hydrophobic component can range between any of the numerical values listed above.

[047] In certain embodiments of the present disclosure, the at least one first part of the electrochemical thermal signaling or marking system further comprises at least one binder. The at least one binder may be a water soluble binder with a melting point ranging from about 80°C to about 650°C. For example, the melting point of the water soluble binder can range from about 80°C to about 160°C, from about 100°C to about 180°C, from about 120°C to about 200°C, from about 140°C to about 220°C, from about 160°C to about 260°C, from about 180°C to about 280°C, from about 200°C to about 325°C, from about 250°C to about 400°C, from about 300°C to about 500°C, and from about 400°C to about 650°C. In certain embodiments, the at least one binder is chosen from polyacrylates, polymethacrylates, methacrylic acid-ethyl acrylate copolymers, polyvinyl pyrrolidones, polysaccharides, substituted polysaccharides, cellulose ethers, polyvinyl alcohols, polyethylene glycols, ethoxylated polyvinyl alcohols, ethoxylated long chain alcohols, and mixtures of any of the foregoing. In further embodiments, the at least one binder comprises at least one ethoxylated long-chain alcohol. A representative example of a suitable at least one ethoxylated long-chain alcohol comprises aliphatic alcohols of between 20 and 50 carbon atoms, although others may be suitably employed. Suitable ethoxylated long-chain alcohols for this purpose are produced by Baker Hughes, Sugar Land, Texas, currently sold under the trade name Unithox Ethoxylates, 700 series.

[048] In other embodiments, at least one of the at least one first part and the at least one second part may comprise additional components. In some embodiments, an additional component includes at least one color changing dye wherein the at least one color changing dye may indicate the stage of the thermal emitting reaction. In certain embodiments, the at least one color changing dye may change color with respect to temperature, pH or other chemical characteristics.

[049] The thermal signaling or marking devices and systems according to the present disclosure have many, if not all, of the following characteristics: low-cost, reliability, compact, safe, easy to deploy, highly efficient, not a source of ignition, non-toxic, bio-degradable, and environmentally friendly. Certain embodiments of the present disclosure provide a relatively uniform heat signature over the surface of the device; other embodiments of the present disclosure provide a device with a temporally tailored heat output; further embodiments of the present disclosure provide a heat generator that will not leak during operation; other embodiments of the present disclosure provide a heat generator which recovers heat from gasses and vapors before venting; and still other embodiments of the present disclosure provide for the recovery of liquid water from water vapor which may be used to further the reaction of the heating chemistry.

[050] In another aspect of the present disclosure, at least one of the parts may be contained inside a housing which keeps the at least one first part of the multi-part electrochemical thermal signaling or marking system separate from the at least one second part, until such time as mixing is desired.

[051] In an additional embodiment, the present disclosure is directed to a containment device comprising at least one first containment part, at least one second containment part, at least one vent member in fluid communication with the outside of the containment device and at least one of the at least one first containment member and the at least one second containment member, and at least one breakable barrier separating the at least one first containment part from the at least one second containment part.

[052] In yet another embodiment, the present disclosure is directed to a containment device comprising at least one first member comprising a sealable opening, at least one second member bound to the at least one first member to provide at least one space between the at least one first member and the at least one second member wherein the at least one space comprises at least one super-corroding alloy and at least one absorbent material. The opening is in fluid communication with the at least one space and the outside of the containment device through which one of water, an aqueous solution, an electrolyte, or mixtures of any of the foregoing thereof may be introduced into the at least one space at which time heat generation commences.

[053] In a further embodiment, the present disclosure is directed to a containment device comprising at least one first containment part comprising at least one super-corroding alloy and at least one absorbent material, at least one breakable containment part disposed within the at least one first containment part, and at least one vent member in fluid communication with the at least one first containment member and the outside of the containment device. The parts of the electrochemical thermal signaling or marking system according to the present disclosure are contemplated to be contained in such housing and/or containment devices.

[054] In further embodiments, the containment device comprises at least one insulating element which minimizes undesirable heat loss. For example, the containment device can comprise at least one insulating element that is at least partially transparent to thermal radiation (e.g., infrared) thereby allowing a thermal imager to detect the temperature of the contents inside the containment device rather than just detecting the cooler outer surface of the containment device. In further embodiments, at least one insulating element prevents thermal energy losses due to undesirable conduction to the air while maintaining desirable radiation of thermal energy. Suitable examples for use as the at least one insulating element include, for example, polyolefins such as polyethylenes and polypropylenes. In additional embodiments, the containment device can be covered with a structure commonly referred to as "bubble wrap" to minimize conductive and convective heat loss while still maintaining high levels of thermal radiation. In certain embodiments, containment devices comprising at least one insulating element can possess a 40°C temperature difference between the contents of the containment device and the outer surface of the containment device.

[055] In some embodiments, the device is comprised of rigid materials which provide a rigid construct to the device. In other embodiments, the device is comprised of flexible materials thereby imparting flexibility to the device and conformity to the surface onto which the device may be disposed.

[056] Without wishing to be bound by any particular theory, the thermal energy generated by the disclosed electrochemical thermal signaling or marking systems emanate in multiple directions. As a result, the electrochemical thermal signaling or marking systems may be designed to direct energy in a desired direction. In some embodiments, the containment device comprises at least one

reflecting element which reflects at least a portion of the emitted thermal energy in a desired direction.

[057] **FIG. 1** depicts a thermal signaling or marking device, **10**, comprising a container with an interior space contained between first member, **11**, and second member, **12**. These members may be joined together by heat sealing, sonic welding, RF welding, vibratory welding or any other suitable means. At least one vent, **13**, is provided to relieve gas pressure generated during operation. This same vent may also be employed to introduce water to the device. A plug, **14**, is provided to seal the container when not in use and to temporarily seal the container during mixing. The plug may be constructed so that it forms a hermetic seal when pressed fully into the hole but permits venting when not pressed fully into the hole. The plug may be designed to snap in place so it will not accidentally dislodge. A strap, **15**, prevents plug **14** from being lost with respect to the device. At least one bond point, **16**, may be employed to join first member **11** and second member **12** together. This serves to maintain a fixed distance between these members, increase rigidity of the device and preserve the internal volume of the device. Additional spacing elements **17**, may be incorporated into the device to further stabilize the structure of the device. These elements may or may not comprise bonds between the first and second members. Strengthening ribs, **18**, may be incorporated into first and/or second members as may be desired to improve rigidity of the structure. An optional hook or hole, **24**, may be provided to facilitate attachment of the device to a nail or string.

[058] **FIG. 2** depicts an exploded view of the device depicted in **FIG. 1**. First member **11**, and second member **12**, when sealed together peripherally, define an interior space which contains first reactive material, **19**, which can comprise the dry ingredient mixture. A peelable, pressure-sensitive seal, **25**, may be used to cover the vent hole prior to use; otherwise; plug **14** depicted in **FIG 1** can serve this purpose. A radiation reflector, **20**, is attached to or otherwise part of second member **12**. This reflector comprises a metal foil, metallized film or any other suitable form of thermal reflector. A thermal insulator, **21**, may be employed to limit conductive heat losses. If desired, an adhesive layer, **22**, may also be provided. In certain embodiments, a pressure sensitive adhesive is used so that the entire device may be readily adhered to surfaces. In such embodiments, a removable release

liner, not shown in the figure, can be used to prevent contamination of the adhesive prior to use.

[059] **FIG. 3** depicts an exploded view of a thermal signaling or marking device **10** wherein plug **14** is integral to second member **12**. A portion of radiation reflector **20**, thermal insulator **21**, and adhesive layer **22** may be removed so that clear access is provided for plug **14** to fit into vent **13**.

[060] **FIG. 4** provides yet another thermal signaling or marking device **10** comprising a frangible vessel, **26**. The frangible vessel comprises water, an aqueous solution, a liquid electrolyte, or mixtures thereof. As used herein, the term "liquid electrolyte" refers to at least one electrolyte combined with one of water or an aqueous solution. When the vessel is broken, the liquid contacts the dry reactants and heating is initiated. Breaking of the vessel may be accomplished by application of force to the device **10** such that at least a portion of this force is transmitted to the frangible vessel. Pressure-sensitive seal **25** covers vent **13** until either manually removed or until pressure build up in the device forces the seal from first member **11** at which time venting occurs. At least one vent **13** may be placed at various and multiple locations to allow venting during the evolution of gasses by the device. Such embodiments may be useful as a self-activating device. For example, such a device, in its un-activated state, may be placed on a roadway. Vehicular or foot traffic which contacts the device will rupture the frangible vessel and initiate the heating reaction.

[061] **FIG. 5** depicts a thermal signaling or marking device **10** comprising a fillable bladder, **27**, wherein water, aqueous solution, liquid electrolyte, or mixtures thereof may be added by removing closure means, **28** and pouring the water, aqueous solution, liquid electrolyte, or mixtures thereof into a fillable bladder, **27**. Said bladder is also frangible, rupturable or otherwise designed to release its contents when sufficient force is transmitted to the bladder. The bladder may be formed in any number of ways including, but not limited to, blow molding, thermoforming, rotomolding or heat sealing two, more or less planar, members together such that a hydraulic reservoir is formed between the members. The bladder may of course be part of, and integral to, first member **11** and second member **12** as well. In either case, the liquid contents are retained in the bladder and kept separate from first reactive material **19** until the bladder integrity is violated at which time the liquid contents of the bladder contact the first reactive material and

heating in commenced. A vent **13** may be employed or a closure means, **28**, of a self-venting type may be used. Such embodiments, like that shown in **FIG. 4**, may also be self-activating. In the case of **FIG. 5**, it is not necessary to have the water, electrolyte or any other liquid components contained within the device until immediately before deployment. This may be desirable if the device is to be transported, stored or otherwise handled in a manner in which the device may become accidentally or prematurely activated.

[062] It is also contemplated that the bladder **27** is a time-release bladder. In certain embodiments, the bladder is made from water soluble materials that will dissolve upon exposure to the liquid components. The rate that the material dissolves, for example, in a matter of minutes, can be controlled by the material used to make the bladder and the thickness of the bladder walls. Suitable materials for these embodiments include polyvinyl acetate, poly(alkylmethacrylate), poly(ethylene) oxide, alkyl cellulose such as ethyl cellulose and methyl cellulose, carboxymethyl cellulose, hydrophilic cellulose derivatives, polyethylene glycol, polyvinylpyrrolidone, cellulose acetate, cellulose acetate butyrate, cellulose acetate phthalate, cellulose acetate trimellitate, polyvinyl acetate phthalate, hydroxypropylmethyl cellulose phthalate, hydroxypropylmethyl cellulose acetate succinate, and polyvinyl acetaldiethylamino acetate.

[063] **FIG. 6** depicts another thermal signaling or marking device **10** comprising a pouched member, **31**, which may be fabricated by bonding, sewing or otherwise joining first member, **32**, to second member, **33**. Seal zones, **30**, create pouches of a defined space. Members **32** and **33** may be fabricated from a cloth-like material such as a woven or a non-woven fabric, or they may be fabricated from perforated films which may or may not be porous. In either case, at least a portion of each of these aforementioned pouches is porous and will permit the entry of water aqueous solution, the liquid electrolyte or mixtures thereof. The pouches formed within the pouch member comprise the dry ingredients as may be desired and serve to maintain relative position of these dry ingredients with respect to the overall device. The pouched member **31** may be staked, bonded or otherwise adhered to at least a portion of the interior of device **10**.

[064] In certain embodiments, the pouches contain an absorbent material such as a super absorbent polymer; in other embodiments the pouches themselves can be made of an absorbent material. In some embodiments, the absorbent

material may be intermixed with the first reactive material to create a more or less homogeneous mixture. Without wishing to be bound by any particular theory, when the second reactive material (for example, water or liquid electrolyte) is added and comes into contact with the pouches, it passes through the pouch wall and is absorbed by the absorbent material. As the absorbent material swells, the mixture containing the absorbent material and the first reactive material grows in volume. As the mixture volume grows, its more or less homogeneous nature is preserved. This prevents grouping of the first reactive material and ensures that sufficient electrolyte is available to reach all of the first reactive material.

[065] While the figures illustrate devices that are more or less planar, there is no limit to the shape of the instant invention. For example, the device may take the form of a rod or bar, similar to a "light stick." Additionally, the device may take the form of a letter, numbers, arrows or other indicia as may be desired. The device may even take the form of a flexible or inflatable structure.

Example 1 Formula for Dry Ingredient Mixture

Super-absorbent Polymer	8.10	g	20%
HDK H15 Silica	0.40	g	1%
Sodium Chloride	1.50	g	4%
FD&C yellow 5/FD&C blue 1	0.004	g	0.0100%
C-5 alloy	20	g	50%
Coated C-5 Alloy	10	g	25%
Total Dry Mass	40.00	g	100%

Table 1

Example 2 Formula for Dry Ingredient Mixture

Super-absorbent Polymer	4.048	g	45.0%
HDK H15 Silica	0.200	g	2.2%
Sodium Chloride	0.751	g	8.3%
FD&C yellow 5/FD&C blue 1	0.002	g	0.022%
C5-alloy	4.000	g	44.4%
Total dry mass	9.000	g	100.0%

Table 2

[066] Other embodiments of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the disclosure disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the disclosure being indicated by the following claims.

WHAT IS CLAIMED IS:

1. A multiple-part electrochemical thermal signaling or marking system, comprising:
 - at least one first part comprising at least one super-corroding alloy and at least one absorbent material; and
 - at least one second part comprising at least one component chosen from water, an aqueous solution, at least one electrolyte, and mixtures of any of the foregoing;
 - wherein heat is emitted when the at least one first part and the at least one second part interact.
2. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one absorbent material is chosen from natural and synthetic polymeric absorbents, hydrocolloid/polysaccharide absorbents, cellulosic absorbents, gum and resin absorbents, inorganic absorbents, gel-forming fluid-interactive adhesive dressings, wool, cotton, lint, at least one super-absorbent polymer, and mixtures of any of the foregoing.
3. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one absorbent material comprises at least one super-absorbent polymer.
4. The multiple-part electrochemical thermal signaling or marking system of claim 3, wherein the at least one super-absorbent polymer is chosen from polyvinylpyrrolidones, sulfonated polystyrenes, sulfonated polyvinyltoluenes, poly-sulfoethyl acrylates, poly-2-hydroxyethyl acrylates, polyacrylates, hydrolyzed polyacrylamides and copolymers of acrylamide with acrylic acid, hydrocolloid absorbent materials, sodium polyacrylate, potassium polyacrylate, lithium polyacrylate, ammonium polyacrylate, and mixtures of any of the foregoing.
5. The multiple-part electrochemical thermal signaling or marking system of claim 3, wherein the at least one super-absorbent polymer comprises sodium polyacrylate.
6. The multiple-part electrochemical thermal signaling or marking system of claim 3, wherein the at least one super-absorbent polymer is present in an amount

- ranging from 0.5 % to 90 % by weight, based on the dry weight of the at least one first part.
7. The multiple-part electrochemical thermal signaling or marking system of claim 3, wherein the at least one super-absorbent polymer is present in an amount ranging from about 20 % to 30% by weight, based on the dry weight of the at least one first part.
8. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein a substantial amount of the at least one super-absorbent polymer is provided with a coating comprising hydrophobic pyrogenic silica.
9. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one super-corroding alloy comprises at least one first alloy component chosen from aluminum, magnesium, zinc, and mixtures of any of the foregoing, and at least one second alloy component chosen from iron, copper, nickel, titanium, chromium, carbon, and mixtures of any of the foregoing.
10. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein a portion of the at least one super-corroding alloy is at least partially coated with a coating chosen from a water-soluble coating, a water-permeable coating, and a water-degradable coating.
11. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one super-corroding alloy comprises magnesium and iron.
12. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one super-corroding alloy comprises particles ranging in size from about U.S. Standard Sieve 14 to about U.S. Standard Sieve 200.
13. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one super-corroding alloy comprises a mixture of particles comprising particles ranging in size from about U.S. Standard Sieve 16 to about U.S. Standard Sieve 20 and particles ranging in size from about U.S. Standard Sieve 45 to about U.S. Standard Sieve 140.
14. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one super-corroding alloy is present in an amount ranging from 5 percent to 75 percent by weight, based on the dry weight of the at least one first part.

15. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the component of the at least one second part is chosen from water and an aqueous solution, and the at least one first part further comprises at least one electrolyte.
16. The multiple-part electrochemical thermal signaling or marking system of claim 15, wherein the at least one electrolyte comprises at least one salt comprising a cation chosen from Li^+ , Na^+ , K^+ , Mg^{2+} , Ca^{2+} , and combinations of any of the foregoing; and an anion chosen from Cl^- , Br^- , I^- , ClO_4^- , BF_4^- , PF_6^- , ASF_6^- , SbF_6^- , CH_3CO_2^- , CF_3SO_3^- , $\text{N}(\text{CF}_3\text{SO}_2)_2^-$, $\text{C}(\text{CF}_3\text{SO}_2)_2^-$, CO_3^{2-} , and combinations of any of the foregoing.
17. The multiple-part electrochemical thermal signaling or marking system of claim 15, wherein the at least one electrolyte is present in an amount ranging from 0.01 percent to 36 percent by weight, based on the weight of the at least one second part.
18. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the component of the at least one second part comprises at least one electrolyte.
19. The multiple-part electrochemical thermal signaling or marking system of claim 18, wherein the at least one electrolyte comprises at least one salt comprising a cation chosen from Li^+ , Na^+ , K^+ , Mg^{2+} , Ca^{2+} , and combinations of any of the foregoing; and an anion chosen from Cl^- , Br^- , I^- , ClO_4^- , BF_4^- , PF_6^- , ASF_6^- , SbF_6^- , CH_3CO_2^- , CF_3SO_3^- , $\text{N}(\text{CF}_3\text{SO}_2)_2^-$, $\text{C}(\text{CF}_3\text{SO}_2)_2^-$, CO_3^{2-} , and combinations of any of the foregoing.
20. The multiple-part electrochemical thermal signaling or marking system of claim 18, wherein the at least one electrolyte is present in an amount ranging from 0.01 % to 36 % by weight, based on the weight of the at least one second part.
21. The multiple-part electrochemical thermal signaling or marking system of claim 1, wherein the at least one first part further comprises at least one hydrophobic component.
22. The multiple-part electrochemical thermal signaling or marking system of claim 21, wherein the at least one hydrophobic component comprises hydrophobic pyrogenic silica.

23. The multiple-part electrochemical thermal signaling or marking system of claim 1 comprises pellets formed from compressed particles of the least one super-corroding alloy.
24. The multiple-part electrochemical thermal signaling or marking system of claim 1 further comprising at least one reflecting element.
25. The multiple-part electrochemical thermal signaling or marking system of claim 1 further comprising at least one at least one insulating element.
26. A multiple-part electrochemical thermal signaling or marking system, comprising:
- at least one first part comprising at least one super-corroding alloy and at least one super-absorbent polymer; and
 - at least one second part comprising at least one component chosen from water, an aqueous solution, at least one electrolyte, and mixtures of any of the foregoing;
 - wherein heat is emitted when the at least one first part and the at least one second part interact.
27. A containment device comprising:
- at least one first containment part comprising at least one super-corroding alloy and at least one absorbent material,
 - at least one second containment part comprising a material chosen from water, an aqueous solution, at least one electrolyte, and mixtures of any of the foregoing,
 - at least one vent member in fluid communication with the outside of the containment device and at least one of the at least one first containment member and the at least one second containment member, and
 - at least one breakable barrier separating the at least one first containment part from the at least one second containment part;
 - wherein heat is emitted when the at least one breakable barrier is broken.