

GLOBAL COOLING BUOYANT COMPOSITION WITH METHODS OF USE
CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This U.S. Patent Application claims benefit of, under 35 U.S.C. 119(e), and priority to prior-filed International Patent Application Number PCT/US19/66660 filed on 16-DEC-2019, entitled “BOUYANT, REFLECTIVE, NANOBIOCOMPOSITE OCEAN REMEDIATION AND CO₂ SEQUESTRATION WITH METHODS OF USE,” which is incorporated herein in its entirety.

BACKGROUND

1. FIELD OF INVENTION

[0002] The present invention is directed generally to a buoyant reflective composition of matter used to perform global cooling, and particularly to a coating used to perform global cooling.

2. BACKGROUND ART

[0003] The concept of non-buoyant fertilizer applied to land crops in agriculture, has been to improve the fecundity of land crops. While the run-off from traditional nutrients is often deleterious to the ocean ecosystem, these practices have nevertheless enabled an explosion in the human population by providing significant land-based foodstuffs.

[0004] The design of construction material has typically been focused on their mechanical perfection, immediate utility, and long-term mechanical performance in buildings and roadways. The matter of what to do with their waste is complicated by the biological after-effects of their production and well as their removal when they are no longer needed in their present forms.

[0005] The realization of the ocean as a better producer of foodstuffs than the land has not yet resulted in political or legislative land-based fertilizer application restrictions or formula-based legal limits on elemental constituents. While permaculture is an ancient method to implement conservation of moisture and soil nutrients in all global cultures, such agricultural practices or designs have been superseded, in favor of modern bare soil fertilization methods producing greater productivity at the expense of their ability to prevent damage to or poisoning of ocean-based ecosystems with very different nutrient requirements.

[0006] Historically, animal manure obtained from animal husbandry has contributed natural nitrogen to fortify soils in prehistorical agriculture. Eventually, it was recognized that the selective addition of important mineral compositions such as refined potassium and the provision of nitrogen and phosphorus from sources other than manure could be introduced to make up for local deficits in the natural agricultural soil environment. The pre-World War I German technology to fix nitrogen using the well-known Haber process, allowed for the simultaneous invention of explosives and

ammonium nitrate artificial nitrogen fertilizer. Each one of these incremental advancements has magnified human power over the natural environment, often creating anthropocentric food security on land at the unfortunate expense of natural biodiversity everywhere.

[0007] Agriculture as well as the fishing industries became further empowered by mechanized machinery. Unfortunately, the global industrial use of fossil fuels to power the machinery of that industrial revolution, has caused the emission of greenhouse gases such as methane, nitric oxides, and carbon dioxide. The unintended result was to create significant warming of the earth and rapid climate change.

[0008] The release of greenhouse gases has acted to reduce reliable growing conditions as well as total global harvests both on land and at sea. The use of concrete to build much of the food storage, processing, and transportation infrastructure to support all industries significantly contributes to greenhouse gas emissions. The power of machines and materials designed to maximize their engineering performance have enabled mankind to bring almost all the productive arable land and waters of the earth's surface into harvest. The continued over-consumption of foodstuffs and biological products has not been accompanied by widespread practices to minimize the overall impact of these industries to replenish natural systems. Giving back to nature to allow it to produce more of what it offers, has more often been overlooked or ignored in favor of economic gain. At present, we have collectively passed the point where the planet was being both polluted to the detriment of life, and simultaneously being harvested of more of its remaining life, than can become replaced by the propagation of new life in any reasonable time.

[0009] No present advancements in infrastructure, technology, or climate change mitigation has yet been able to keep up with the magnification of human labor by machines to strip the world of any available renewable resource or to protect the diversity of species from unanticipated and detrimental changes in the environment caused by the advancement of multiple technologies. The consequences of a failure to return to nature what was needed to continue its role to provide, has now become catastrophic. A new paradigm that unites the need for new construction materials and new methods of fertilization in agriculture and aquaculture is urgently needed to restore healthy global economies as well as to replenish rapidly depleting planetary renewable resources.

[0010] A concept that unites construction material utility with the empowerment of agriculture and aquaculture in a single composition of matter is not only lacking conceptually, it fails to be understood as necessary to be incorporated into both one and the same practice and invention. Therefore, global solutions to climate change and industrial infrastructure are not

considered in solutions to food security, and their association in any meaningful context continues to be inconceivable in reduction to practice. This deficit of understanding continues to propagate an inappropriately polarized differentiation of utility from those things that we use to build and transport, from those other things that we use to grow food and protect biodiversity.

5 [0011] One example of ecological-technological blindness is the failure of technology to unite architectural construction material in dams with recognized water resource management deficits. The need to conserve water from evaporation behind freshwater storage dams is widely recognized, but a composition of matter to achieve this economically is not yet invented. High evaporation savings are possible if physical covers are used on small farm dams less than about 10
10 hectares in size. Physical covers can also be constructed to shade larger dams, but they are uneconomic due to the high capital investment required in construction materials needed to support a load over large areas. Some semiarid and arid regions that can justify the increased cost of water using standard covering materials, may justify a physical cover over large area dams. Generally, chemical monolayers are thought to represent the most cost-effective option for protection of
15 agricultural water from evaporation in large area dams. One of the areas of cost for chemical monolayers, is the need for frequent measurement and manual or automated release of appropriate quantities of these protective materials, as the wind blows them away. Architectural constructs as well as water monolayers have been the subject of numerous studies. The use of acres of wind resistant floating plastic ping pong balls, has exposed concerns about the formation of microplastic
20 particles from abrasive wear and sunlight exposure. While there are clear deficiencies in the current state of the art water storage construction covers, products, and techniques, the potential for significant improvement exists. However, despite decades of searching for better answers, no cost effective construction material or hybrid chemical additive method has been found worldwide to reduce water cover susceptibility to wind displacement, and this observation applies equally well
25 for reducing evaporative loss from large area irrigated farming as it does for large public water storage dams.

[0012] New teaching must focus on the appropriate implementation of modern technologies to improve the application of nature's own use of similar materials and processes prior to aligning them with the purposes of industrial activity. Such efforts must be applied successfully to non-
30 verdant regions of the oceans and deserts to empower future economic and biological benefit through nutrient and water resource management. In particular, the ultimate drain of all surface runoff is to the ocean. Therefore, with as many land-based products and construction material

compositions as possible, a general theme or motif must be designed with their fate on arrival at the ocean in mind. This more general constraint on utility must examine how every significantly mass-produced technological product will eventually travel to the ocean by natural flow and erosion mechanisms.

5 [0013] A conceptual paradigm shift is now required to support human civilizations in all its diverse forms by restoration of the biodiverse foundation of earth's food chains. Complementary answers to complex problems in apparently diverse fields are required to avoid mass extinction and the loss of biodiversity as the one true source of long-term economic benefit for future humanity. Failure to implement a halt to over-harvesting and decline in the global environment may otherwise
10 lead to the extinction of humanity.

[0014] Therefore, the basis for human wealth must now be targeted to the production of biodiversity using whatever advancement of materials can be used in every form of substantial infrastructure and transportation. A shift in science to serve nature first while serving mankind will be central to this conceptual reform. Only when materials are considered as multi-functional global
15 environmental tools, can their utilization enable the rescue of all human activity to the mutual benefit of all extant species and monetary economies. New multifunctional materials should function to amplify or improve the basic nutrient delivery mechanisms of nature while acting to perform climate engineering functions as a prerequisite to multiple application in all forms of construction, energy production, food production, and transportation infrastructure.

20 [0015] Therefore, what is needed is a composition of matter that is primarily designed to be a medium to enhance the biological productivity of the oceans as the largest and most diverse provider of foodstuffs, even as these compositions may be formulated to address apparently unrelated functions of use in common technological operations and infrastructure. Such compositions, even those intended to be used as fertilizers, must urgently become revised and
25 updated to incorporate consideration of their ultimate resting place in the oceans. We must now emerge from misdirected attempts to magnify nitrogen availability in the manner of slow release ammonium nitrates, and other state of the art fertilizer inventions. Somehow, these past successes must find dependent methods to function cooperatively with multifunctional materials capable of performing carbon cycle, nitrogen cycle, and evaporative moisture adjustments while addressing
30 thermal radiation management.

[0016] Ancient methods of permaculture are still taught without the advantage of technological enablement, yet agriculture using technology has never been as powerful as it is today.

Significant new insights to the natural processes of nutrient supply must become globally available to rescue planet Earth from deterioration in the ability to harbor life in all forms. This is especially important in the rapidly advancing field of climate change management technology. Less fertilizer must become able to serve the needs of all plant life on this planet. Global cooling materials to adjust planetary temperature and availability of oxygen compared to carbon dioxide can and must be developed.

SUMMARY OF THE INVENTION

[0017] These and other advantages of the present invention will be further understood and appreciated by those skilled in the art by reference to the following written specifications, claims and appended drawings.

[0018] The invention provides a buoyant reflective composition, having a plurality of hollow silicon dioxide glass microspheres in which microsphere size ranges from about 500 nanometers to about 650 nanometers, in which each microsphere contains therein an air inclusion bubble about 400 nanometers in diameter and has a true density of from about 0.1 g/cm³ to about 0.65 g/cm³ with a nominal true density of about 0.15 g/cm³, and is within a range of between about 1% by weight to about 98% by weight of the total, with a nominal value of about 23% by weight. Titanium dioxide particles are included, having a specific surface area of about 10 square meters per gram, the particles being of a mean size of about 140 nm with a distribution spanning from about 30 nm to about 300 nm, in which a greater proportion of the particles is anatase phase, in which the isoelectric point is about 4.1 in water, and in which an approximate fraction of nanoparticles in the composition includes between about 0% to about 10% by weight of the total TiO₂ particles. The composition also includes an aliphatic component mixture having at least one C16 or C18 aliphatic alcohol with at least one slightly water soluble C16 or C18 aliphatic carboxylic acid, in which the binder of density of the aliphatic alcohol is about 0.82 g/cm³ with a combined melting point of between about 46 degrees C to about 70 degrees C, such that the hot melted fluid mixture achieves a process viscosity of between about 6 mPa to about 10 mPa prior to cooling and solidification to the local ambient environmental temperature of use, and in which the total composition has a density of less than about 1.0 g/cm³ and is buoyant in water. In first selected embodiments of this composition, the at least one C16 or C18 aliphatic carboxylic acid is between about 0% by weight to about 10% by weight, and in other selected embodiments, the titanium dioxide content is between about 0% by weight to about 5% by weight. In yet other selected embodiments further include up to about 5 % by weight iron oxide as Fe²⁺, Fe³⁺, or both.

[0019] The invention also provides methods of cooling an environment, including providing a substrate; and applying an effective amount of a preselected buoyant reflective coating to the substrate. In selected embodiments, the preselected buoyant reflective coating includes a first composition of at least one C16 or C18 aliphatic carboxylic acid between about 0% by weight to about 10% by weight, and wherein the substrate includes construction or roofing materials, and the first composition applied to the materials provides thermally reflective waterproofing and insulation to the materials. In other selected method embodiments with this composition, the titanium dioxide content is between about 0% by weight to about 5% by weight. In one embodiment of this composition with this titanium dioxide content, the substrate includes surface water and this composition reduces evaporative loss of water by up to about 30%. In yet other selected method embodiments of this composition with this titanium dioxide content, the substrate includes surface water, and composition on the surface water reduces the evaporative loss of the treated surface water by up to about 30%. In still other selected method embodiments of this composition with this titanium dioxide content, the substrate includes a rear surface of a solar electricity producing panel, in which the composition directs solar reflectivity onto the panels, in which the operating temperature of the solar electricity producing panel is reduced. In still other selected method embodiments of this composition with this titanium dioxide content, the substrate includes a root support substrate used in hydroponic horticulture, and in which applying the effective amount of this composition includes applying a continuous or a discontinuous surface coating to the root support substrate. In still other selected method embodiments of this composition with this titanium dioxide content, the substrate includes a permaculture soil surface in which applying the effective amount of this composition includes applying a continuous or a discontinuous surface coating to generate a reflective permaculture surface. In still other selected method embodiments of this composition with this titanium dioxide content, the substrate includes a native sandy soil of an arid or a semi-arid desert, in which, once applied to the native sandy soil this composition conserves essential subsoil nitrogen and conserves moisture from substantial evaporative or volatile loss. In yet other selected method embodiments of this composition with this titanium dioxide content, the substrate includes a settlement of fungal growth or mosses in a soil, in which insulative thermal protection by this composition is conferred to the settlement allowing further cultivation of light-reflecting foliage, food-producing crops, or both, in the soil. In yet other selected method embodiments of this composition with this titanium dioxide content, the substrate includes incident light reflection onto an underside of an agricultural plant leaf, in which once this composition is applied the underside of

agricultural plant leaf is irradiated for the purpose of light-mediated sterilization of pathogenic organisms from invading the stomata or breathing orifices of plants, and in which disease transmission to humans or animals who consume such agricultural plant leaf is avoided.

[0020] In still other method embodiments of this composition, up to about 5% by weight of iron oxide as Fe²⁺, Fe³⁺, or both are added and the substrate includes surface water of any body of water including oceans, in which once this iron-supplemented composition is applied to the surface water evaporative loss of treated surface water is reduced by up to about 30%, and in which diatoms or plankton in or near the treated surface water, or both are nourished thereby.

[0021] Some embodiments are described in detail with reference to the related drawings. Additional embodiments, features, and/or advantages will become apparent from the ensuing description or may be learned by practicing the invention. In the FIGURES, which are not drawn to scale, like numerals refer to like features throughout the description. The following description is not to be taken in a limiting sense but is made merely for describing the general principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

[0023] FIG. 1 illustrates silicon dioxide, titanium dioxide, cellulose, hydrophobic C16 and C18 aliphatic alcohols, and hydrophilic solubilizing carboxylic acids, according to the teachings of the present invention;

[0024] FIG. 2 illustrates experimental data for the comparison of albedo or reflectance of snow, titanium dioxide, sand, and water, according to the teachings of the present invention;

[0025] FIG. 3 illustrates basic solar energy irradiance, according to the teachings of the present invention;

[0026] FIG. 4 illustrates solar energy flux that is differently distributed as a function of the angle of irradiance at the surface of earth, according to the teachings of the present invention;

[0027] FIG. 5 illustrates a model of the reflectance of titanium dioxide if it were distributed at the equator, compared to snow reflectance reduced by the angle of irradiance near the poles, according to the teachings of the present invention;

[0028] FIG. 6 illustrates the structure of a cluster of buoyant reflective hollow silicon dioxide glass spheres imbedded in hydrocarbon biopolymers, according to the teachings of the present invention;

[0029] FIG. 7 illustrates the effect of reduced evaporative loss of agricultural water surfaces by the buoyant reflective global cooling composition, according to the teachings of the present invention;

5 [0030] FIG. 8 illustrates the use of granulated crumbles to coat and thermally insulate exposed agricultural soils, according to the teachings of the present invention;

[0031] FIG. 9 illustrates an agricultural hot melt spray application method using the composition of the present invention to reflectively cover and coat soil surfaces, according to the teachings of the present invention;

10 [0032] FIG. 10 illustrates the woven filament mulch or nonwoven filament mulch application method using the buoyant reflective coating of the present invention, according to the teachings of the present invention;

[0033] FIG. 11 illustrates methods of use of the composition of the present invention when applied as a granulated reflective soil surfacing at a solar farm for electrical energy production, according to the teachings of the present invention;

15 [0034] FIG. 12 illustrates the buoyant reflective global cooling coating application of the composition of the present invention onto roofing composite, adobe mud bricks on walls, agricultural levees, or food storage huts, according to the teachings of the present invention;

20 [0035] FIG. 13 illustrates the method of use of a commercial 3D Printer to apply the buoyant reflective global cooling coating of the present invention, according to the teachings of the present invention;

[0036] FIG. 14 illustrates a schematic to make and use Global Cooling Buoyant Marine Crumble, according to the teachings of the present invention;

[0037] FIG. 15 illustrates a schematic to make and use Global Cooling Buoyant Agricultural Crumble, according to the teachings of the present invention;

25 [0038] FIG. 16 illustrates a schematic to make and use Global Cooling Buoyant Beads, according to the teachings of the present invention; and

[0039] FIG. 17 illustrates a schematic for applying Global Cooling Buoyant coatings to parts, according to the teachings of the present invention.

30 [0040] Some embodiments are described in detail with reference to the related drawings. Additional embodiments, features, and/or advantages will become apparent from the ensuing description or may be learned by practicing the invention. In the FIGURES, which are not drawn to scale, like numerals refer to like features throughout the description. The following description is

not to be taken in a limiting sense but is made merely for describing the general principles of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0041] The following detailed description, taken in conjunction with the accompanying drawings, is merely exemplary in nature and is not intended to limit the described embodiments or the application and uses of the described embodiments. Any implementation described herein as “exemplary” or “illustrative” is not necessarily to be construed as preferred or advantageous over other implementations.

[0042] Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary, or the following detailed description. It is also understood that the specific devices, systems, methods, and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined in the appended claims that there may be variations to the drawings, steps, methods, or processes, depicted therein without departing from the spirit of the invention. All these variations are within the scope of the present invention. Hence, specific structural and functional details disclosed in relation to the exemplary embodiments described herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present embodiments in virtually any appropriate form, and it will be apparent to those skilled in the art that the present invention may be practiced without these specific details.

[0043] Various terms used in the following detailed description are provided and included for giving a perspective understanding of the function, operation, and use of the present invention, and such terms are not intended to limit the embodiments, scope, claims, or use of the present invention.

[0044] Embodiments of the present invention provide a buoyant reflective composition of matter used to perform global cooling, to make shelter, to manage water, and to grow food synergistically. Short term personal survival and long-term planetary ecological needs are served at once, providing the widest possible simultaneous cross-functional industrial utility over the entire life cycle of the composition. It is believed that compositions of the present embodiments provide a thoughtful first confluence of materials properties to empower the economic delivery of evaporative control, temperature control, nutrient conservation and release, and enough engineering

structural functions to ensure their overlap with future food security and climate remediation for the enhancement of biodiversity and the improvement of the human condition.

[0045] Embodiments of the present invention includes a composition having construction material utility, permaculture enablement, aquaculture benefit, and long term global cooling capability when the materials properties such as buoyancy, reflectivity, thermal insulation, modulus, and evaporative permeability are combined and directed at meeting basic human needs of shelter, water, and food prior to the ultimate function and destination of this formulation to operate on the surface of water, such as the ocean. One exemplary composition of this material and listing of ingredients with proposed commercial vendors is tabulated as follows:

10 TABLE I.

Substance	Composition (weight percent)	Source or Vendor
C16, C18 aliphatic alcohols	2% to 80% (70% nominal)	Oxidized petroleum distillate, or palm kernel oil extract
C16, C18 aliphatic carboxylic acids	0% to about 10% (add for dissolution)	Oxidized petroleum distillate, or palm kernel oil extract
Titanium Dioxide (TiO ₂)	0% to 10% (0.2% nominal)	FDA Certified Food-Grade, fine ground powder. (see properties below) www.roha.com ROHA U.S.A., L.L.C. 5015 Manchester Avenue St. Louis, Missouri, 63110, USA
Silicon Dioxide Glass Spheres (SiO ₂)	1% to about 98% (23% nominal)	www.3M.com/glassbubbles 3M Advanced Materials Division 3M Center St. Paul, MN 55144, USA

[0046] The titanium dioxide (TiO₂) used herein is of the type normally supplied in food-grade TiO₂ powders. Typical properties are a low specific surface area (around 10 m²/g), a greater proportion of the powder is in the form of a pure crystalline anatase phase, having a low isoelectric point of around 4.1 in water, a mean particle size of about 140 nm with a distribution spanning from about 30 to about 300 nm, and an approximate fraction of nanoparticles that is typically comprised

between 17 and 36% by weight of the total fine ground mass of TiO₂ crystal particles. The TiO₂ powder sometimes has traces of rutile crystalline phase. The low isoelectric point is related to the natural phosphate impurities that sometimes are found at TiO₂ crystals surfaces. These particles are solid particles and have no ability to float in water or to become buoyant except in adherent association with the hollow reflective silicate glass microspheres of the global cooling composition.

[0047] The reflective composition of hollow silicon dioxide (glass) microspheres with optional titanium dioxide reflectivity enhancement exhibits an impressive combination of macroscale, mesoscale, and nanoscale features contributing to a final combined reflectivity and buoyancy performance. This composition leads to the improvement of many lives and livelihoods impacted by climate change, at significantly reduced costs to society. One aspect of the present invention is the use of hollow silicon dioxide particles (e.g., hollow silicon dioxide glass spheres) that confer an insulative function to surfaces such as soils, as well as to ocean or freshwater surfaces. One part of this function is enabled by the incorporation of a measured amount of air to a spherical shaped volume of silicon dioxide glass. This enables the rapid long-term transport of the buoyant reflective mixture, capable of performing global cooling when deployed at the land or water surfaces of the earth in sufficient quantities.

[0048] Embodiments of the present invention advance the science and technology of fertilizer materials, by providing a hollow sand material as a central component in advanced composite permaculture compositions fabricated to protect existing soil nitrogen, phosphorus, and potassium on land surface soils, while releasing and delivering silicate, and optional iron, or nitrogen in transient application to freshwater and more permanent delivery to saltwater marine environments. Additionally, the placement of a small quantity of as little as 1 percent of reflective titanium dioxide into the buoyant reflective silicon dioxide glass microsphere composition is able to raise the reflectivity of this mixture from 86% to greater than 99% to better enable particular embodiments.

[0049] In another aspect, deficits in the proper cycle of carbon, oxygen, and nitrogen are achieved by evaporative control of water from both land surfaces, and water surfaces in the marine and fresh water environments by an appropriate mixture of long chain 16- or 18-carbon atom alcohols and carboxylic acids to be released from within the compositional ensemble. The mixture can be distributed as monomolecular layers on water surfaces to reduce evaporative losses.

[0050] In a general aspect of the present invention, an insulative value is achieved by air entrapment within buoyant silicon dioxide glass microspheres to confer temperature moderation

capability to the abutting water or soil surfaces by day or night, thereby protecting the earth surfaces from extremes in thermal and seasonal variations associated with global warming. In a related aspect, the sharp discontinuity in the refractive index of silicate glass in the buoyant, substantially round glass particles is achieved at the internal glass-to-air interface. The high radius of curvature within this type of particle is on the order of the wavelength of incident light, which has a maximum irradiance at a wavelength of about 550 nanometers (about 0.55 microns). This allows significant reflection of incident light even at noon, or zero degrees of incidence, from vertical rays of sunlight, because a significant quantity of incident light rays will enter regions of this interface at a high grazing angle to the internal air bubble entrapped within this structure. This material has about 86% reflectivity before the materials of the present composition are added to confer additional reflectivity and other added functions.

[0051] In another related aspect, the mechanical reinforcement of spherical silicate glass particles has the mechanical advantage of structural reinforcement conferred by the arch of the sphere to distribute applied loads in all directions away from the load application point. This confers the property of mechanical reinforcement to soft matrices having low elastic modulus, such as the C16 and C18 aliphatic hydrocarbons having alcohol or carboxylic acid functional groups of the present composition used as the primary constituent to bind all the components of the present composition into clusters and other shapes of the constituents suitable for construction materials, road surfacing agents, reflective agents, and the like.

[0052] In yet another related aspect, the presence of titanium dioxide, especially the natural component of the anatase crystal form, allows the creation of multiple hydroxyl free radicals from abutting water contact on exposure to sunlight. These hydroxyl free radicals then transfer a free radical to the aliphatic C16 and C18 materials of the present invention as part of the free radical initiation reaction by diffusion. The wetting action of the aliphatic constituents then allow free radicals to adhere to aliphatic plastic microparticles that may be present in aquifers or ocean surfaces as pollutants. Attractive abutment between such particles is an electrostatic phenomenon that allows them to couple their free radicals to the surfaces of hydrophobic plastic particles, where these reactions initiate the depolymerization of the floating microplastic particles in sunlight in a chemical process known more commonly as free radical initiation and free radical propagation. The resulting chemical conversion of plastic yields the non-toxic reaction products of carbon dioxide and water, where the overall light-initiated catalysis using titanium dioxide herein, is more commonly

understood by the generally understood term photolysis, which means a light initiated chemical reaction.

[0053] In still another related aspect, the presence of titanium dioxide, especially the anatase crystal form impurity, allows the creation of multiple aliphatic free radicals from abutting aliphatic alcohols in contact with the titanium dioxide particle on exposure to sunlight. The presence of oxygen in air and the additional presence of hydroxyl free radicals then act to oxidize the hydrophobic aliphatic alcohol to generate the respective aliphatic carboxylic acid. The conversion of aliphatic alcohol to aliphatic carboxylic acid permits significantly enhanced solubility, and the eventual complete dissolution of the organic components of the present invention. Thus, the “crumble clusters” of the present invention, when exposed to sunlight, will eventually dissolve, and become digested by marine organisms. At the same time, some of this oxidized material in the form of carboxylic acid, will dissolve in water to help form a thin monomolecular layer on that water surface, along with trace amounts of less soluble C16 and C18 alcohols. Such a monomolecular surface layer is called a Langmuir-Blodgett layer, and the constant replacement and diffusion of this layer is expedited by the titanium dioxide as a chemically actuated release agent to fulfill the evaporation control embodiment of the present invention.

[0054] One aspect of the monomolecular surface layer is provided by the synergistic reflectance of buoyant hollow sand to supplement that of oxidized aliphatic hydrocarbons of the present invention. Normally, the effect of an aliphatic organic monolayer a few atoms thick on water, is to enhance the reflectivity of moving (not still) water with wavelets at angles of incidence greater than 45 degrees, where this effect is greatest on cloudy days having diffuse energy and highly randomized angles of illumination. This mechanism of light scattering to achieve sunlight reflectance has historically been limited to less than about 10 percent of increased reflectance except at irradiance angles greater than about 75 degrees, as may appear on sunny days only near sunset or sunrise. Unfortunately, and of extreme practical relevance, the solar flux or energy input is significantly greatest at noon on sunny days, when most evaporative loss appears, and all significant reflectivity of water vanishes. The novel incorporation of floating silicates having a sharp index of refraction discontinuity at the internal air bubble with the glass, serves to significantly redirect light even at high noon, and can become greater than 99% reflective at all angles of incidence when the composition of the present invention is functionally complemented by the appearance of a monolayer coverage of C16 and C18 oxidized aliphatic hydrocarbons collectively floating on water.

[0055] In a related aspect, the material composition of the present invention is of great utility at the equatorial latitudes, where the energy of direct overhead sunlight imparts significant energy irradiance to cause major drought over land, and major destructive typhoons and hurricanes over the oceans. Deployment of large mesh size clusters over these regions will be helpful to resist wind induced displacement while significantly reducing temperatures and evaporative water loss from the ocean and reducing the intensity of soil structure destruction by dust storms on land that are responsible for the advance of land-based desertification. In another related aspect, the material composition of the present invention will find a great utility in the external protection of dikes, levees, and adobe structures associated with the most common technology available to the poorest communities in the most populous of countries. This composition confers a significant waterproofing benefit in delaying the need to significantly reconstruct buildings, homes, food storage huts, road surfaces, and other infrastructures that have remained substantially unchanged in their adobe construction materials since before recorded history. Moreover, the unavoidable loss of some of the particles in every type of these constructs will act to assist the remediation of oceans and waterways close to these population groups, thereby providing shade and essential nutrients to allow the continuous enhancement of foodstuffs such as booms in the population of fishes, edible algae, and seaweeds for the greater good of the human condition while enhancing the ability of the oceans to remain biodiverse while these lifeforms and renewable organic materials are being harvested by mankind. In still another related aspect, the mechanism of light reflectivity is greatly enhanced by presence of even as little as 0.01 percent of 99.9% reflective titanium dioxide adhered to clusters of buoyant particle clusters, up to an amount where the cluster becomes too heavy to float. Economic considerations as well as the loss of biopolymer binder materials from normal dissolution in water and sunlight, bring practical titanium dioxide additive concentrations to between about 0.5 and 5 percent of the buoyant sand weight in the final composition with aliphatic alcohols and aliphatic carboxylic acids. The heated biopolymer mixture composed with adhered glass microspheres after cooling and solidification, can be broken up, crushed, or crumbled to achieve granulated particles that better resist wind and remain on soil surfaces. These particulates can then be classified or sorted by granule size by passing through wire mesh screens having a value of spaces between wires to achieve a granule assortment as desired. In this aspect, individual clusters of any of the obtained mesh-sized granules are routinely able to achieve 99% or greater reflectivity, where the number of such clusters per square meter does not have to be great to provide significant reflectivity. Any size granules at angles of incidence greater than 30 degrees will be capable of

excellent reflectivity among the wavelets of breeze at the surface of rippled water, even on sunny days at noon. In still another related aspect, the combined reflective mechanisms of the present invention confer the ability to reflect undesirable scattered light from the back of solar energy collection devices, while insulating the shadowed regions of these devices from the direct thermal radiation of heat from the soils beneath their structures. This reduction in device temperature adds decades to the lifetime of the solar energy collection panels, while boosting the electrical energy output of these devices in direct accordance with their reduced internal resistances as a function of decreased operating temperature. At the same time, these same reflective mechanisms of the present invention can be applied as granular or mesh materials to the soils beneath and between the solar energy panels. This immediately reduces the heat generated by soils in arid or semiarid regions by changing a light reflectance of about 10 percent to a light reflectance of about 99%. The interactive purpose of using the composition of the present invention as both a thermal barrier material in the panel construction as well as a soil reflectance enhancer in the spaces between the panels, is to recapture that energy that is ordinarily lost between panels, and redirect it to shine on the solar panel active surfaces instead. This results in as much as 20% enhancement of solar panel operation at 45 degree incidence angles without adding any extra panels, simply because the solar flux or light energy in watts per square meter, has been substantially increased both by soil reflectance and back panel reflectance of the same material applied to different surfaces. The conceptual separation of the device operation from the treatment of the soil over which it operates, is therefore revolutionized in paradigm. This results in an immediate economic return that can be realized in the implementation of the simultaneous application of construction teachings and soil amendments embodied by the confluence of simultaneous methods inherent in the cross-disciplinary applications of the present invention. It is notable that implementing both applications of the same composition to the same objective in this embodiment, enhances the economic and biodiversity coupling needed to enhance the ecology of the planet while achieving economic success.

[0056] Yet another aspect of the monomolecular surface layer is to reduce the loss on evaporation of water at the water surface, by 20 to 30 percent in an economically achievable way. Past technologies using the concept of molecular water layers to control evaporative loss, needed constant vigilance by automated measurement equipment, or even more costly manual determinations to find when wind has pushed the surface coating on the water surface, away from the regions being treated. At this moment, the monomolecular layers required replacement by the addition of new additive to the treated waters. Embodiments of the present invention remedies this

deficit by the inclusion of round grains of buoyant silicates that now allow significant storage of aliphatic organic biopolymer into the spaces between these particle shapes to permit a slow diffusion based release function that is always active to replace any locally wind-induced displacement of these molecular layers. Yet another aspect of the use of greater than 4 centimeter diameter clusters of the composition is to increase the mass and the viscous drag of each such cluster to the point that they are not easily displaced by wind. This allows the deployment of particle clusters to regions that are expected to be more swept by strong winds while maintaining the ability to resist displacement from the treatment site, such as for reservoirs needing evaporative control layers. Yet another aspect of the monomolecular surface layer is to create of pool of phase transfer free radicals capable of depolymerizing itself, and to couple with plastics and microplastics at the surface of rivers, lakes, and oceans to remediate them by depolymerization of them as well. The phase transfer medium is the C16, and C18 aliphatic alcohols and carboxylic acids. The carboxylic acids are most able to dissolve in water. The alcohols are less able to dissolve in water. Both have affinity to hydrophobic plastic particle surfaces. The reaction products of sunlight-irradiated titanium dioxide produce sufficient free radicals to depolymerize and therefore remediate the organic plastics and other organic pollutants with the creation of water and carbon dioxide as their cumulative and non-toxic reaction products.

[0057] In an exemplary embodiment, the composition of the present invention acts to confer significant long-term humidity conservation to arid and semi-arid surface soils. The presence of humidity encourages the growth of fungi that bind and hold soil particles together. In one aspect, the enabled retention moisture and fungi serves to prevent the premature evaporative release of nitrogen from soils into the atmosphere, leaving them fertile for new plant growth. In another aspect, the enabled retention of moisture acts to confer a higher heat capacity to the moist soil. This means that significantly more energy is required to heat the soil, and once warmed, significantly more energy is available within it to confer stored heat release. These effects of enhanced heat capacity are properties of water that acts to moderate soils to provide thermal stability during periods of cooling and darkness as well as periods of heat and solar irradiance.

[0058] Referring now to the drawings wherein like elements are represented by like numerals throughout, FIG. 1, illustrates molecular structures of the components of a buoyant reflective global cooling composition 10. The glassy fragment of silicon dioxide 12 has localized distortion of the bonds between the silicon (Si) and the oxygen (O) away from more regular lattice locations that are characteristic of more amorphous regions in silicon dioxide glass. The aliphatic

C16 hydrocarbon having alcohol functionality in molecule 14, is easily oxidized in the presence of titanium dioxide catalyst 18 in the presence of ambient sunlight and ambient reactive oxygen species species created in the presence of oxygen or water, to create the corresponding C16 carboxylic acid 16. Both C16 aliphatic alcohol 14 and C16 carboxylic acid 16 can be added in different ratios to adjust the time to dissolution in water without waiting for sunlight to initiate the chemical transformation of C16 aliphatic alcohol 14 into C16 carboxylic acid 16. By not adding any of C16 carboxylic acid 16 and maximizing the quantity of C16 aliphatic alcohol 14 and the C18 aliphatic alcohol 15, the presence of these waxy alcohols is able to provide significant water resistance. Reducing or eliminating the addition of titanium dioxide photocatalyst 18 will promote longevity of the water-resistant aspect of this composition. Likewise, increasing the presence of TiO₂ catalyst 18 allows the chemical oxidation transformation of C18 aliphatic alcohol 15 into C18 carboxylic acid 17 in like manner as for C16 aliphatic alcohol 14 into C16 carboxylic acid 16, by the action of sunlight and reactive oxygen species (ROS). In all cases, the optional use of titanium dioxide mineral additive 18 is provided in the form of a fine ground powder. Optional cellulose additive molecular structure 19 is made of beta glucose, where molecular stiffness within the molecular carbohydrate linkages confer support in a three dimensional configuration, wherein each successive glucose unit is rotated 180 degrees around the axis of the polymer backbone chain relative to the last repeat unit, for a sum of repeat structural units indicated by the subscript m denoted outside the bracketed region of 19. Buoyant reflective global cooling silicon dioxide glass compositions require 12 and some organic binder 14, 15, 16, 17 functioning as adhesive to create a non-structural surface coating, wherein some methods of application allow the addition of optional biodegradable support cellulose fiber 19 in the physical form of a fibrous web, or a woven web having pores to allow aeration, or to simplify their economic deployment as biodegradable rolls or woven mats. Cellulosic molecular structures 19 may vary in fiber length or vegetation derived impurities without substantial deviation from their biodegradable and physical support function. The composition thus manufactured, is eventually disposed and eroded to be released into the environment where it is able to migrate its constituent materials to the oceans, where they will act as a coating to further serve the ocean ecosystem and protect the Earth's climate from excessive heating by adding their reflectivity to the surface waters on which they float. It is understood that the representative molecular structures of this composition will have different physical shapes, physical dispersions, and orientation of form when used as a buoyant reflective global cooling composition. The buoyant reflective global cooling

coatings are to be deployed, applied, supported, or deposited by the use of exemplary application methods such as those called out herein.

[0059] Referring now to FIG. 2, there is illustrated experimental data that is in the common and public domain about the percentage (%) reflectance or albedo of four pure materials where the property of reflectance as a function of wavelength displayed in nanometers may be helpful to understand their relative characteristics. Dashed black line 24 with short dashes represents the reflectivity of snow. It is useful to note that the reflectivity of pure snow is 99 percent around the maximum solar output of about 550 nanometers. Little of the solar irradiance at the surface of the earth arrives less than 400 nanometers of wavelength. This is useful to understand the experimental reflectance data of titanium dioxide 22, which maintains 99% or greater reflectance well into the deep red (about 650 nm to about 1000nm) and near infra-red wavelengths of light greater than about 960 nanometers. A large part of the retained heat of the earth arrives at greater than 960 nanometers, therefore reflectance in this region is useful to allow the global cooling technology of the present invention to operate because of the high reflectance in this spectral region. Overall, titanium dioxide is more reflective than pure snow. Dotted line 26 represents the plot of reflectance of pure crystalline silicon dioxide sand, which is about 10 percent near the solar maximum output of about 550 nanometers and drops to 8 percent or less reflectance depending on the level of moisture and other mineral impurities. It is notable that the data represented by line 26 is very different than the reflectance of hollow silicate glass spheres of grey line with long dash at curve 29, as this material has a regular and sharp interruption of the index of refraction at the interior surface with air, are not crystalline in structure, and are explained in more detail in FIG. 6. The hollow glass silicon dioxide glass spheres reflect 86 percent of the incident solar radiation at the maximum solar output of about 550 nanometers, thereby conferring only 13 percent less reflectance than titanium dioxide performance. For some applications, this reflectivity might be considered quite sufficient, however the multipurpose biological and climate cooling objectives of the present invention do not allow this acceptable reflectance property to dominate the entire composition design either in utility or in method. The solid black line 28 represents the experimental reflectance data of liquid water at all angles of light incidence that are less than about 85 degrees. Pure liquid water is substantially absorbing of all solar radiations at most visible and all infrared frequencies, having only a trace of reflectance being no greater than about 4 percent at the 550-nanometer solar maximum irradiance output. Considering that the oceans of planet earth are responsible for about 75 percent of the planetary surface coverage, it now becomes clear from the reflectance properties illustrated in this

graph, the most severe contributor to global warming is the most common liquid water 28, the second worst is a second most common land-based pure crystalline silicate sand 26, and the most direct way to alleviate this combined lack of reflectance is to design a planetary surface coverage to replace the disappearance of snow 24 with some combination of the inexpensive but reflective materials 22, 29, in accordance with the teachings of the present invention.

[0060] FIG. 3 illustrates solar energy flux that is differently distributed as a function of the angle of irradiance at the surface of earth 30. The sun 31 provides illuminance with a maximum spectral output at about 550 nanometers, where the energy of all these rays of light 34 arrives at earth with a known power in watts per square meter. When this energy falls normal or perpendicular to the surface of the earth at or near the equator, the absorbed energy induced rise in temperature 36 is maximized. Less rays per square meter arrive at the polar regions of the earth, resulting in minimized temperature 35. The geometry of this angular dependence of power on surface incident angle is shown by the use of the grey triangle 38 where the incidence of arriving ray 37 and the exit of the departing ray are a function of the hypotenuse or the longest side of this triangle. If the hypotenuse is more perpendicular to the field of arriving rays, then this side obtains more rays per unit length. Therefore, the same angular dependence of energy that appears as the angle of the sun by latitude, and also cycles each day according to another apparent angle of the sun in the sky that varies with a maximum at noon when the sun is visible. These two angular functions each follow a cosine trigonometry at approximately orthogonal orientations that is associated with one of representative triangle 38 in each area of the square meter of solar flux measurement at the surface of the earth during the sunlit day. Other significant factors determine the solar irradiance effect on the overall climate. The water surface of the earth 32 absorbs more radiation than the land areas 33, where the land areas are about 25 percent of the total surface area.

[0061] Referring now to FIG. 4, there is graphed the values of solar energy flux in watts per square meter at noon at the date of the solar solstice on the right vertical Y-axis, where this value is scaled to 100% on the leftmost vertical Y-axis. The results of simple angular earth irradiance model 40, is plotted as curve 42 that varies from zero at the southern pole at -90 degrees of latitude, reaches a maximum for the irradiance at the equator at latitude zero at noon, and falls again to zero at the north pole at 90 degrees of latitude. While ice and snow coverage vary with season, the dotted lines 44, 46 represent the average latitude of ice-covered regions for the south and north polar regions, respectively. While snow has an excellent reflectance as shown in FIG. 2, the amount of angular dependence at a polar latitude reduces the actual ability to reflect solar energy to less than 10 percent

of the theoretical maximum at the equator. This combination of material properties and angular dependent scale factor is illustrated demonstrated in FIG. 5.

[0062] FIG. 5 illustrates a scientific comparison of the effective reflectance of two materials when placed at two latitudes. The reflectance of titanium dioxide if it were distributed at the equator is shown at curve 52. The achievement of 99 percent effective reflectivity only exists for titanium dioxide material when distributed at the equator. If it were deposited at the poles, then the scale factor of FIG. 4 will reduce the entire curve to less than 10 percent effective reflectance. It is not possible to keep snow at the equator, compared to the actual percentage of reflectance of snow as illustrated in FIG. 2, because at sea level this material will melt. The true reflectance of pure snow as it becomes reduced by the effective average angle of irradiance that is present near the poles, is represented by the curve using the dashed line 58. In conclusion, less than 10 percent of the of the surface of earth need be covered at zero latitude by a highly reflective material such as titanium dioxide, to achieve the effective reflectance of snow at any one of the polar regions.

[0063] Referring now to FIG. 6, there is illustrated the structure of a cluster of hollow silicon dioxide glass spheres 60. Silicon dioxide glass microsphere in cross section view 62 has a diameter of about 400 nanometers or 0.4 microns to maximize interaction with light rays of about the same wavelengths, and is provided a closed cell internal air cavity 61 having a large discontinuity in the index of refraction between the transparent glass and the air. This discontinuity acts to reflect light rays that approach from almost any direction, as indicated by the large white right angle arrow representing a light ray reflecting from interior glass surface at location 61. Individual silicon dioxide glass microsphere is shown in a perspective view 66 as it is displaced from adherence at the cluster composition of 63, as shown by the direction of white arrow 64. This displacement from cluster 63 is substantially enabled by dissolution of the organic binder 67, where the identity of that binder composition is a mixture of aliphatic alcohols and aliphatic carboxylic acids of C16 or C18 carbon chain length, as illustrated by the molecular structures in FIG. 1. Cluster 63 is a representative fragment obtained from chopping a solid cast material, where the multiplicity of such fragments is then classified according to those that can pass a standard mesh size, as explained in the schematics of FIG. 11 and FIG. 12. The composition of cluster 63 includes from about 1 to about 5 percent by weight of natural titanium dioxide mineral crystals ground to a very fine mesh size, being of nominally about 2 percent by weight to achieve a total cluster reflectance of greater than about 99 percent reflectance. Titanium dioxide crystal 65 is represented with a hatched pattern and a complex shape to represent the random facets and angular geometry of these crystals. A bent

white arrow represents the reflection of a light ray at the location of crystal 65 from the surface of titanium dioxide. Crystal 65 has the ability to become activated under solar irradiation to function as a generator of reactive oxygen species that are able to depolymerize and oxidize binder 67, thereby accelerating the egress of multiple buoyant silicon dioxide glass spheres 68 from cluster 63 as adherence to the remaining mass of cluster 63 is reduced.

[0064] FIG. 7 illustrates the effect of reduced evaporative loss of agricultural water by a dissolved biopolymer from buoyant reflective crumble, as well as the effect of reducing harmful algae within bodies of water 70, such as water storage dams and the ocean surface waters to which they drain. Aliphatic alcohols and aliphatic carboxylic acids, while digestible to marine and freshwater organisms, is not affected by the presence of ultraviolet light in sunlight. The presence of hydroxyl radicals from water (DOT OH) 72b and other reactive oxygen species (ROS) are supplied by the interaction of a multiplicity of particles of titanium dioxide 79a with sunlight. ROS are then used for the oxidative dissolution of plastic microparticles 76, as well as to reduce the growth of populations of noxious organisms 74, which may include harmful algae or some types of anaerobic bacteria, or both. It is to be noted that plastic microparticles naturally obtain a net positive electric charge, whereas silicates and silicon dioxide glass microspheres 75 obtain a net negative charge. These opposing charges will attract floating microplastics 76 to floating microspheres 75 and their clusters 78 to expedite microplastic photolysis as a form of depolymerization by accelerated oxidation in the presence of sunlight. At a location of water 72a not near 71, the presence of harmful algae 74 is located below this region of water 72a is controlled when some titanium dioxide particles 79b become separated and drift downward, or are present at 79b within a multiplicity of the buoyant clusters 78 to generate reactive oxygen species. Reflective oxidized aliphatic hydrocarbon monolayer 71a is present by at the air interface with water when released by dissolution of clusters of the composition of the present invention 78 to supplement the reflectivity of buoyant hollow silicate particles 75, while acting to reduce the evaporative loss of water as illustrated by the direction of upward pointing grey arrow and the grey cloud 73a, by as much as 30%. Multiple buoyant hollow silicate particles 75 with no remaining or no added structural aliphatic hydrocarbon alcohols or carboxylic acids between them is still able to cast significant local shade for a reduction in temperature by light reflectivity to occur, but at less ability to reduce evaporative loss as illustrated by the direction of upward pointing grey arrow and the larger grey cloud of moisture release 73b associated with 20% or less moisture loss reduction from the surface of bare water 72. Multiple buoyant hollow silicate glass particles 75 dissolve in water over time to

feed ubiquitous oceanic plankton, which organisms require silicon as a significant and often missing or deficient element in global ocean surface waters. The enhanced growth and incorporation of carbon into these organisms results in the removal of carbon dioxide from air and upper surface waters to deposit the dead silicate based creatures, along with the carbon in their bodies, onto the ocean bottom where carbon can remain encapsulated for about 600 years to thousands of years. Eventually, dissolved or partly digested hollow silicate glass microspheres 75 allow the escape of internal entrapped air to result in the loss of their buoyancy property, such that the ruptured glass microspheres 75 sink to the ocean bottom in the same manner that blown sand and dust from natural silicate sources also find their way to sink to the ocean bottom. Likewise, the eventual dissolution of aliphatic hydrocarbon alcohols and carboxylic acid binder from buoyant clusters 78 will act to release some non-buoyant titanium dioxide 79a, which then sinks from the point of origin in cluster 77 to the bottom of the body of water into which it is immersed, as shown by the downward pointing direction of the heavy black arrow under the release of titanium dioxide 79b from cluster 77. Some pollutant microplastic particles may be present in the surface layers of water where these can become attracted to solid particles 76 of aliphatic hydrocarbon alcohols or carboxylic acids, or particles 76 may become covered in a monolayer of these same aliphatic molecules. Such coverage can act as a phase transfer catalyst to accelerate the attraction of reactive oxygen species and expedite the propagation free radicals 72b generated from sunlight at water surfaces in the depolymerization of polymeric microplastic particles.

[0065] FIG. 8 illustrates an agricultural soil amendment 80 of a buoyant reflective global cooling composition. Multiple clusters 82 being represented by white circles, are illustrated as buoyant clusters 82 of hollow glass spheres bound with aliphatic hydrocarbon alcohols and carboxylic acids dispersed in mounded farmed soil rows 89, to reduce evaporative loss from water in irrigation canals 86. The upward pointing grey arrow shows the direction of moisture loss 83. Bent white arrows 84 illustrate the reflectance of light rays from two of a multiplicity of the illustrated white circles used to represent clusters of the composition of the present invention. Magnified inset view 88 shows the components of one representative buoyant cluster, provided with a binder of aliphatic hydrocarbon alcohols and carboxylic acids 87, and titanium dioxide particle 83 among silicon dioxide glass spheres.

[0066] Farmed soils typically are turned over, using a plow, and this activity may bury many of the clusters 82. However, the buoyancy of these clusters allows them to make their way back to the soil surface each time that these soils are irrigated or subjected to rainfall, thereby allowing their

more efficient function in moisture evaporation control, soil temperature reduction by light reflectance, and the carrying of any optional nutrient impurities that have been added as supplemental nutrients, as clarified in the process charts of FIG. 14, 15, and 16, when used in accordance with the global cooling objectives of the present invention.

5 [0067] FIG. 9 illustrates a hot melt spray application method using the buoyant, reflective global cooling composition furrowed agricultural soil 90. Magnified insert 94 includes hollow glass microspheres 96 with optional titanium dioxide 91 bonded together into an organic matrix consisting of biodegradable aliphatic alcohols and carboxylic acid 93, to form multiple agglomerates represented by multiple solid black spheres of buoyant reflective composition 97 bearing the
10 magnified representative view 94. Composition 94 forms a coating over furrowed and mounded soils 98, being placed by a hot melt of forming droplets 97 on spraying from agricultural spray head 101 and being supplied by a heated reservoir 100 guided over the fields to be treated with the melted form of buoyant reflective composition to form a solidified coating 97. Furrows of width D1 are designed to separate mounded soils of width D2 such that seeds may be planted into the grooves of
15 the soil between furrows and mounds. The thickness of buoyant reflective composition 97 is greatest between such grooves so that rainfall will tend to slide off the mounds and into the grooves during periods of little rainfall so that a multiplicity of seedlings 92 will sprout from the concentration of water at these locations. The distance between seedlings D5 is represented by schematic 99 where the presence of six black circles having white centers represents the top view of plants separated by
20 distance D2 being identical to the width of mounded soil 98 having plants separated by the same distance but illustrated in a side view of D2. It is assumed in this method of use, unlike the method illustrated in FIG. 8, insufficient water is available for irrigation, rainfall is limited in a semiarid climate, and the protection of soils by spraying the composition of the present invention is sufficient to both hold together sand and soils while limiting moisture evaporative loss and nitrogen fertilizer
25 outgassing loss, while converging infrequent water into the low spaces wherein seeds are germinated into sprouted plants 92. The highly reflective nature of the composition 97 illustrated by enlarged inset 94 of the present invention is indicated by the white angled arrow. This specular reflectivity allows soil temperatures to remain low during daily solar heating while the insulative nature of the hollow glass microspheres in this composition allows the soils below the thickness of composition
30 97a, 97b to be insulated and remain warm during cold nights, thereby increasing seedling survival and allowing greater agricultural productivity. In particular examples, plants 92 are annual

strawberries, however plants 92 may also be corn or maize, almond trees, avocado trees, tomato plants, beans, peas, carrots, and the like.

[0068] FIG. 10 illustrates non-woven fabric mulch or woven filament mulch application methods used to dispense the mulch embodiment 1000 of a buoyant, reflective global cooling composition. Material 1030 can be a bioplastic but can also be a geotextile having fabric fibrils 1050 that capable of absorbing and retaining mixture 1070 of an aliphatic alcohol (cetyl alcohol) and a carboxylic acid (stearic acid), hollow glass silicon dioxide microspheres 1040, and optional titanium dioxide 1060 components of a buoyant reflective composition, which is illustrated by the magnified view in the circular inset 1080 in a top view of the cloth soil mulch rectangular segment 1010. Fabric mulch segment 1010 can be cut from stored portion of material 1030 and dispensed onto the ground from unrolled layers of the continuous web of material 1030. The roll width D5 is like segment width of 1010, also a width of D5. The segment 1010 of fabric mulch material 1030 can be applied to the top surface of soil over the formed soil mound 1015 as shown by the distances indicated near distance D5. Dotted lines also indicate the distances between plant rows on the same mound at D4, and the distances between plant rows at the nearest proximal soil mound D3. Fabric or plastic mulch covering segment 1010 can be provided with multiple holes, in which six holes 1017 illustrate two rows of holes. Each hole corresponds to the location where one seedling 1020 has sprouted to grow through the hole provided with a spaced distance of D4 from the nearest neighbor hole. Actual distances between plant rows D3, D4 will vary depending on the type of crop planted, where such crops may include strawberries, onions, and the like. Distance D5 can vary depending on the desired mound width formed by mechanized farming equipment. The woven mulching material 1030 used to bear a buoyant reflective composition can be any rolled textile. Such rolled textiles may include a geotextile being any type of silicate bearing fiber, any non-woven mat of cellulose such as paper fiber or adhered wood fibrils, or like rolled carrier fabric able to adhere and position the composition 1080 onto the desired agricultural growth substrate 1015. The composition of plant growth substrate 1015 can be natural soil, or a hydroponic open cell foam bearing substantially the same function to grow plants as soil.

[0069] Referring now to FIG. 11, there is illustrated multiple simultaneous and mutually interactive methods of use of composition 1111 of the present invention when applied to soil, roadways, and device structures at a solar farm for the purpose of benefit to electrical energy production 1100. Arid and semiarid lands having little or no vegetation 1110 are optimal grounds for the installation of arrays of a multiplicity of solar panels 1120 that are mounted on frameworks

to point them towards the location of the sun in the sky using mechanical actuators 1150. Clusters of composition 1111 can be deposited onto and among the particles of soil as generally represented by wavy line regions 1160. One such wavy line region has an expanded view inset to show the composition of a representative cluster composition with binder 1180 among multiple hollow silicon dioxide glass spheres, and a titanium dioxide particle 1130. These clusters can also be deposited as a hot melt spray illustrated in FIG. 9, or they may be embossed into a mat mulch 1030 that is unrolled onto the ground as illustrated in FIG. 10, or they may be extruded with fibers to form into a woven mat mulch 1165 that is unrolled onto the ground where the filaments of this type of permeable agricultural cloth can be extruded from a conventional extruder prior to weaving, as illustrated in FIG. 13. These methods of deposition 1160, 1165 are intended to be used as alternative depositions of the composition of the present invention to explicitly reduce or minimize displacement or erosion by strong wind or flooding rains as these conditions often appear in arid regions in certain times of the year, and increasingly often everywhere else as a result of extreme weather events associated with global climate warming.

[0070] It is understood that the powder flakes from the clusters of this composition will bind to natural silicon dioxide grains (sand) in the soils, and will act to limit the evaporative loss of moisture as well as to limit nitrogen loss from soils beneath them. In addition, the reflection of light energy from soil rather than absorption of light as heat will serve to send more energy to the solar panels as indicated by the direction of upward pointing grey arrow 1140, wherein the reduction of ambient solar heat reduces undesirable electrical resistance to the proper function of solar panels 1120. The rear of each solar panel is also coated with the same composition of the present invention, so that light reflected from the rear of each panel can be directed away from it to fall on the active surfaces of nearby solar panels, thereby also increasing the amount of light able to be converted to electricity at the active solar panel surface. The energy no longer lost to heat production, is therefore converted to electricity production for economic benefit at the solar farm 1190. Soil moisture retention will help to reduce evaporative loss 1190. Moreover, fines and particulates used to limit dust at the access roadways will eventually become washed to the oceans or will be blown out to sea on dust storms. Therefore, the solar farm business becomes a material supplier of the composition of the present invention by way of water cycle erosion to help ocean life biodiversity increase, and to cause global cooling of the ocean, even as it is applied onto land surface areas. In addition, local desertification is halted or reduced by the creation and maintenance of damp regions under the specular reflectance composition of this invention, thereby increasing carbon capture in

the production of fungal biomass in desert soils, making this location more suitable for hardy mosses and lichens to grow. Figure 11 illustrates the paradigm used to understand the need for multiple simultaneous and mutually interactive objectives for the composition of the present invention when applied to soil, roadways, and device structures, to result in increased biomass and moderation of the global climate to achieve local economic objectives in alignment with significant ecological benefits in accordance with the intent of the present invention.

[0071] FIG. 12 illustrates the buoyant, reflective composition of the present invention added to the surface of adobe mud bricks in walls, agricultural levees, and food storage huts 1200. When manufactured to allow air transport through adobe, a percentage of granulated clusters of buoyant reflective composition is added to a mixture of straw and rammed earth, shown in expanded insert 1210. This composition reduces the rate of evaporative moisture loss, as these bricks are being formed. Expanded inset 1210 shows the composition of global cooling buoyant reflective composition 1212, 1215, where the organic binder 1270 is C16, C18 oxidized aliphatic alcohols as shown in FIG. 1. Multiple hollow silicon dioxide glass spheres 1260 may be added to the binder, along with titanium dioxide particles 1280. This composition can enhance reflectivity and can increase the material strength. The application of the composition 1215 by paint brush 1220, or by wrapping with rolled fabrics or webs 1225, which can be useful to carry and distribute the composition 1212 are specific embodiments of alternative application methods. These methods may be used to improve the mechanical performance, water resistance, solar photolytic degradation resistance, thermal insulation properties, and reflectance of constructed material 1230. The material 1230 can be composite roofing tiles nailed to the roof of a conventional house, or can represent bricks such as, without limitation, composite adobe mud bricks. Traditional construction materials 1230 are subject to weathering and rainfall that eventually cause such structures to weaken or fail, as shown by the direction of falling rain from precipitated moisture 1240 downward in the direction of the grey arrow onto the materials of structure 1230. The applied buoyant reflective global cooling composition cools and forms a sunlight and weather resistant hardened coating to, the exterior surfaces of material 1230. This waterproofing effect immediately improves the human condition by preserving the shelters of economically disadvantaged populations from periodic destruction, so that the labors, residences, and stored foods of these people can be spent in consumption of goods and the sale of produce in economic activities. The enhanced reflectivity of light away from the outer surfaces 1250 will act to keep these structures cool, while the insulative value of the air retained within the hollow silicon dioxide spheres of the composition within 1215, 1212 will better

maintain the desired temperatures within these structures. This composition may provide biological and environmental benefits in poor agricultural regions using adobe brick or composite roofing construction. The spallation products and eroded fragments from the weathering of the buoyant, reflective global cooling composition may eventually drain to canals, riverways, and out to the nearby ocean regions. This spallation and erosion has the effect of cooling the local coastal waters, introducing dissolved silicates from the hollow glass microspheres into the seas that are necessary for the growth of diatoms, and increasing the size of fish that can be harvested to feed these populations from the nearest marine harvesting activities. The many interactive functions of the composition of the present invention provide inseparable climate change benefit from the dispersal of the composition of the present invention, while performing a useful transient function as a coating onto existing engineering materials used in construction infrastructure, and then providing a long-term food security enhancement by achieving long term global cooling in areas where it is most needed. It is understood that the presence of reflective buoyant silicate microspheres is a significant component to create ecologically functional waste streams for the purpose of coating and reflecting light from natural land and water surfaces after any and all economic objectives, applications, and utility in these methods of use are achieved.

[0072] FIG.13 illustrates a commercial 3D Printer used to apply the buoyant, reflective global cooling composition in additive manufacturing 1300. A material is deposited by three-dimensional additive manufacturing that consists of buoyant reflective global cooling composition 1392. The spooled filament 1310 is composed with composition 1392 wrapped on a spool for disbursement of a filamentary thread 1320. This commercially available method of raw material delivery is often used to deliver a uniform size of filamentary raw stock material in state-of-the-art additive manufacturing. It is understood that a spectrum of commercially available feedstock forms also can be used to deliver the composition 1392. In review, some 3D-printers require the delivery of a powder composition or a mechanical delivery of same sized beads. Yet others may require that a reservoir of liquid melt be directly metered out from the moving printer head 1380. In each case, the manner of dispensing is not critical to demonstrate the general method of additive manufacturing, and the use of filament 1320 in this embodiment is sufficient to support the general manufacturing method of additive manufacturing to correctly utilize this composition 1392. Computer controlled metering device 1330 uses electric power (not shown) to actuate a DC-stepper motor (not shown) that is connected to a feeding gear 1340. The feeding gear 1340 mechanically turns on action to dispense a length of filament 1320 that is pinched between it and a compliant,

slightly deformable rubber wheel 1350 on command to print a small amount of the composition 1392. A desired length of filament 1320 then enters a heated reservoir 1370 that feeds liquefied material to heated print head 1380. Both 1370 and 1380 are often composed with deformation resistant metal that can transmit thermal energy yet retain molten materials and allow ease of
5 cleaning by release of the metered composition when the printing process is completed. Extruded placement of the composition 1392 is indicated by extrusion 1382. Expanded inset of composition 1392 shows the composition of global cooling buoyant reflective extrudate 1382, where the organic binder 1394 is C16, C18 oxidized aliphatic hydrocarbons, as shown in FIG. 1. By using multiple hollow silicon dioxide glass spheres 1396, and by having titanium dioxide particles 1398 added to
10 the composition to enhance reflectivity, the material strength and the overall artistic appeal of the final additive manufactured part can be increased. It is understood that the presence of reflective buoyant silicate microspheres is a significant component to create ecologically functional waste streams for the purpose of coating and reflecting light from natural land and water surfaces.

[0073] FIG. 14 illustrates a flow diagram to make Buoyant Marine Crumble S1400. In step
15 S1410, a desired binder material is created by adding about 5 to 7 percent water soluble aliphatic C16 or C18 carboxylic acid by weight to a remainder (about 95% to about 93%) of C16 or C18 aliphatic alcohols by weight. This binder material mixture composition requires about 2 months of time to dissolve the organic components of the buoyant reflective global cooling composition in salt or fresh water, to fully release all hollow glass silicates as free-floating particles. Incorporation of
20 greater quantities of C16 or C18 carboxylic acids will significantly shorten dissolution time of the solid mixture on exposure to water or moisture. In step S1420, this binder material composition is brought about 80 to 90 degrees C, to melt the organic components, depending on the mixture. Mild stirring is sufficient to combine all components. In step S1430, add 20 to 25 percent by weight of hollow silicon dioxide glass spheres and the desired amount of about 1 to about 5 percent by weight
25 of finely ground titanium dioxide powder. In step S1440, up to about 5 percent iron Fe²⁺ and Fe³⁺ may be added for materials destined for dispersal in oceans, especially regions of the Southern Ocean, which have known iron nutrient deficiencies. Otherwise, step 1440 can be skipped. In step S1450, optionally about 1 to 10 percent nitrogen emission nutrients such as urea or ammonium hydroxide may be added to materials destined for dispersal in regions of the Southern Ocean, where
30 some areas close to Antarctica have known nitrogen nutrient deficiencies. Otherwise, step S1450 may be skipped. In step S1460, the formed composite ingot is cooled to room temperature. In step S1460, the composition is chopped and granulated for sorting by size in a wire mesh or other size

classification system prior to distribution. In all cases, it is understood that the presence of reflective buoyant silicate microspheres is a significant component to create ecologically functional waste streams for the purpose of coating and reflecting light from natural land and water surfaces after any and all economic objectives, applications, and utility in these methods of use are achieved.

5 [0074] FIG. 15 illustrates a schematic of a Buoyant Agricultural Crumble preparation. In step S1510, a desired quantity of about 0 to 70 percent water soluble aliphatic C16 or C18 carboxylic acid by weight may be added to a balance (100%) of C16 or C18 aliphatic alcohols by weight to create a binder mixture. This mixture provides may generate complete control, on the order of months to years, of soil protection, depending on the desired time to dissolve the final crumble composition. The time of dissolution for any formulation in water can be performed using a USP dissolution analyzer as a guide of field use solubility for buoyant reflective global cooling coatings and compositions. The protocols and calibrations for dissolution are specified in United States Pharmacopeia (USP) General Chapter 711, Dissolution, and may be accessed by the public without cost, at <https://www.usp.org/harmonization-standards/pdg/general-methods/dissolution>. In step 10 S1520, this composition is brought to melt the organic components at about 80 to 90 degrees C, depending on the mixture proportions. Mild stirring is sufficient to combine all components. In step S1530, about 20 to about 25 percent by weight of hollow silicon dioxide glass spheres may be added to the desired amount of about 1 to about 5 percent by weight of finely ground titanium dioxide powder. Maximization of water-soluble carboxylic acid can speed the dissolution of the buoyant 20 reflective composition in soils that may have limited exposure to moisture or humidity. This allows later adherence of the water-soluble components with soil particles. In step S1540, the formed composite ingot is cooled to room temperature. In step S1550, the ingot is chopped and granulated for sorting by size in a wire mesh classification system prior to distribution according to the desired method of use. For example, the purpose of covering a water reservoir to retard evaporative loss and 25 reduce thermal heating may require pieces or chunks of about 5 centimeters diameter. Covering soils with a granulated coating to reflect light may require pieces or grains of about 5 millimeters in diameter. In step S1560, the granulated composition of the present invention may be tilled into agricultural soils prior to planting seeds for the desired crops. In step S1570, the agriculturalist may decide to add traditional and commercially available fertilizer to the soil. It is understood that soil 30 can be fertilized independently of the present composition. Therefore, it is completely optional to add phosphates (P_2O_5), nitrates (urea, ammonium nitrate), and potash (K_2O) as part of traditional farming practices without deviating from the intent of the buoyant crumble to confer reduced soil

surface temperatures and thereby prevent drought induced soil nitrogen loss. In step S1580, water can be applied to the agricultural field during the natural process of rainfall or by directed irrigation. This irrigation allows the buoyant properties of the granulated buoyant, reflective composition to percolate upward after having been buried by plowing. The presence of water allows the crumble
5 pieces to float up to the exposed soil surfaces where they may then act to reflect sunlight and conserve moisture. This effect can be a technological precursor to better enable the practice of permaculture, using a composition embodiment of the present invention, instead of complete reliance on the availability of dead plant matter as a cover for bare soils where none exists. Eventually, wind-blown clusters of the composition of the present invention, or water-borne clusters
10 of the present invention, will make their way to the ocean to achieve the designed benefit to oceans and climate that arrives at the designated end of their product lifecycle, when used in accordance with the teachings of the present invention. It is understood that the presence of reflective buoyant silicate microspheres is a significant component to create ecologically functional waste streams for the purpose of coating and reflecting light from natural land and water surfaces after any and all
15 economic objectives, applications, and utility in these methods of use are achieved.

[0075] In FIG. 16, a schematic of method 1600 to make buoyant reflective beads from the buoyant, reflective composition. In step S1610, a binder material can be formulated by adding about 1 percent by weight of water soluble aliphatic C16 or C18 carboxylic acid to a balance by weight of C16 or C18 aliphatic alcohols. This formulation can generate about 36 months of time to dissolve
20 the final composition. In step S1620, this binder material is brought to melt the organic components at about 80 to 90 degrees C, where the actual melting point will depend on the ratio of organic components of differing melting points selected for dissolution rate in water that are to liquify during the homogenization process. Mild stirring is sufficient to combine and mix all components. In step S1630, about 20 to about 25 percent by weight of silicon dioxide glass spheres may be added to
25 about 5 percent (by weight) of finely ground titanium dioxide powder to produce the composition. In step S1640, a hydraulic or air or electric screw activated actuator may be used to automatically dispense a thin stream of the melted composition into a flowing stream of cold water to form solid beads, in which the rate of dispensing helps to define the bead size. In step S1650, the formed beads are drained of water and allowed to dry. Then, if desired, the bead size may be further refined by
30 classification through wire meshes to retain the mesh size of interest for later applications. In step S1660, the composition is formed into beads, is sprinkled and distributed over crop soil. Typically, this soil is tilled and graded before planting seeds. Alternatively, sprinkle onto desert sands for de-

desertification, or onto solar farm soils and behind device panels, or onto dirt access roadways, as desired to achieve the desired soil surface reflectivity, moisture evaporative loss mitigation, and the desired soil nutrient conservation. This technique can encourage the level of permaculture technology advancement that is desired. In step S1670, by watering the soil, the effect of buoyancy in the composition of the beads causes these materials to rise to the surface, reducing soil temperature, and increasing the soil reflectance. It is understood that the presence of reflective buoyant silicate microspheres is a significant component to create ecologically functional waste streams for the purpose of coating and reflecting light from natural land and water surfaces after any and all economic objectives, applications, and utility in these methods of use are achieved.

5 [0076] FIG. 17 illustrates a flow diagram of an additive manufacturing method 1700 to make customized parts of customized shape and size from the raw materials of the buoyant, reflective composition. In step S1710, alkyl C16, C18 alcohols can be combined with a preselected quantity of C16, C18 carboxylic acids to adjust the extrusion viscosity and organic binder material melt temperature. By adding increased or greater amounts of C16, C18 carboxylic acids to the binder mixture ratios, a faster dissolution time in water will result. In step S1720, this mixture of solids may be heated to about 90°C with shear mixing to form a homogeneous fluid melt of the organic binders. In step S1730, about 15% to about 20% hollow glass silicates are combined with about 4% to about 5% of fine ground food grade TiO₂ as tabulated within Table I of this specification, to be stirred into this hot fluid melt mixture. In step S1740, the hot mixture buoyant, reflective composition can be extruded into a continuous filament. This cooled filament can be wound onto a spool for later metering. In step S1750, install the filament spool containing the composition into a commercially available 3D printer machine configured to accept the filament diameter metering. The 3D printer may feed, heat, fuse, and print the desired mulch web, pots, or agricultural designs such as holes for the emergence of plants, from the additive deposition and cooled material composition. In step S1760, the filaments can be woven into an agricultural cloth for use as mulch, for pressing onto cellulose, bark, or paper fibers to manufacture roll-out soil coverings, or to bind plant roots into biodegradable pots or root protectors for plants. The delivery article thus manufactured, has a finite lifetime and a useful but time-limited product duty. Once this service has reached its product lifetime, the delivery article is disposed and eroded, and the global cooling buoyant reflective composition of the present invention will be released into the environment where it is able to migrate its constituent materials to the oceans, where they will act to further serve the ocean ecosystem and protect the Earth's climate from excessive heating by adding their reflectivity

to the surface waters on which they float, to be in accordance with the design and intent of the composition of the present invention.

[0077] As variations, combinations and modifications may be made in the construction and methods herein described and illustrated without departing from the scope of the invention, it is
5 intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative rather than limiting. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments but defined in accordance with the foregoing claims appended hereto and their equivalents.