Abstract:
Title: SEED TREATMENT FORMULATIONS

A seed treatment mixture useful to produce coated seeds having a combination of good flowability characteristics and good plantability characteristics, while also having low dust-off characteristics, includes an agricultural active component and a binder formulation. The binder formulation includes a latex carrier, a wax and mica. In one embodiment, the latex carrier comprises a styrene-acrylate based copolymer. In various aspects, the invention relates to seed treatment mixtures, binder formulations, methods of treating seeds, and coated seeds produced thereby.
SEED TREATMENT FORMULATIONS

Cross-Reference to Related Application

The present application claims the benefit of the filing date of U.S. Provisional Application Serial No. 61/640,693 filed on April 30, 2012, which is incorporated herein by reference.

BACKGROUND

The present invention relates generally to the formation of a coating on a seed and seed treatment formulations for same. More particularly, the invention relates to seed treatment formulations useful to produce coated seeds having a combination of good flowability and plantability characteristics, while also having low dust-off characteristics. Seed treatment formulations having this combination of features have long been sought; however, prior to the present invention, efforts in this regard have not been highly successful. In various aspects, the invention relates to seed treatment formulations, methods of treating seeds, and coated seeds produced thereby.

The control of insects and related arthropods is of extreme importance to the agricultural industry. Insects and related arthropods annually destroy an estimated 15% of agricultural crops in the United States and even more than that in developing countries. In addition, competing weeds and parasitic and saprophytic plants account for even more potential yield losses. Some of this damage occurs in the soil when plant pathogens, insects and other such soil borne pests attack a seed after planting. In the production of corn, much additional damage is caused by rootworms, which are insect pests that feed upon or otherwise damage the plant roots; and by cutworms, European corn borers, and other pests that feed upon or damage the above ground parts of the plant. The period during germination of the seed, sprouting and initial growth of the plant is particularly critical because the roots and shoots of the growing plant are small and even a small amount of damage can kill the entire plant. Moreover, some natural plant defenses are not fully developed at this stage and the plant is vulnerable to attack.

The use of pesticides to control pests in crops is a widespread practice that has gained a high degree of commercial success because it has been shown to
increase crop yield. One approach for delivering pesticides to their desired locus of action that has been developed as a substitute for soil or foliar spraying is the application of pesticides directly onto plant seeds. Seed treatment with pesticides has the advantages of providing for the protection of the seeds, while minimizing the amount of pesticide that is required and limiting the amount of contact of workers with the pesticide.

The term "seed treatment" generally refers to application of a material to a seed prior to or during the time it is planted in soil to improve the handling characteristics of the seed, protect the seed prior to germination, support the germination and/or support the growth of the resulting plant. Some seed treatments are employed solely for the purpose of improving the handling characteristics or other physical characteristics of seeds, and include no agricultural active ingredients. Other seed treatments bind one or more active ingredients to seeds for various beneficial purposes. For example, seed treatments that include one or more active ingredients are commonly used to ensure uniform stand establishment by protecting against soilborne diseases and insects. Typical examples include the application of pesticides such as fungicides, insecticides and plant growth regulators. Systemic seed treatments may eliminate, or at least reduce the need for, traditional broadcast sprays of foliar fungicides or insecticides for certain early season airborne diseases and insects.

A number of problems have been encountered in the development of seed treatments. For example, binder formulations that have been developed to date typically have one or more of the following disadvantages: low formulation stability, low seed flowability, high levels of dust-off of the one or more active ingredients and other coating ingredients from the seed prior to planting, and poor plantability characteristics. For example, treated seeds prepared from many formulations proposed in the prior art tend to be dusty, presumably as a result of the coating being abraded by the seeds' coming into contact with each other during ordinary drying, handling and planting operations. In addition to being unpleasant for personnel who handle the treated seeds, dustiness increases potential exposure to inherent hazards of the active ingredient(s) present in the coating. Dusting also has the possible effect of reducing the efficacy of the
coating due to loss of a portion of the active ingredient(s) from the seed. Another major problem encountered in the development of binder formulations is that various potential ingredients that would otherwise impart beneficial properties to a seed coating have an overriding negative effect on the flowability of the coated seeds.

A number of seed coating additives have been evaluated for inclusion in binder formulations in an effort to remedy problems such as low seed flowability and excessive dust-off. However, it has been discovered, and has become well known, that a seed coating additive selected to reduce dust-off tends to have an adverse effect on seed flowability. For example, a typical approach for reducing dust-off is to include ingredients that increase the "stickiness" of a coating so that it will be less susceptible to dusting. Such ingredients, however, have been found to cause seeds treated therewith to have unacceptably poor flowability and plantability characteristics. Indeed, the very "stickiness" properties that would tend to reduce dust-off are the same properties that create the flowability problems. On the other hand, a typical approach for increasing seed flowability characteristics is to include ingredients that reduce the "stickiness" of the coating; however, such efforts have had the adverse effect of increasing dust-off.

Accordingly, there is a need in the art for new binder formulations that are stable and that are effective to produce coated seeds having good flowability and plantability characteristics and also good (i.e., low) dust-off characteristics. The present application addresses this need and provides additional benefits.
SUMMARY

This application addresses the needs discussed above by providing binder formulations that have been found to produce coated seeds having advantageous combinations of characteristics. Such formulations are effective to adhere active ingredients to seeds, while producing coated seeds that show good flowability and plantability properties and low dust-off.

In various aspects, the present application provides binder formulations, methods for making and using same to treat seeds, and coated seeds made using same. The binder formulations can have varying amounts of water therein, but are typically provided as a concentrate of the ingredients therein that is suitable for being diluted with water shortly before application to seeds. In another embodiment, the binder formulation is proved as a re-dispersible solids mixture that can be mixed into a predetermined quantity of water shortly before application to seeds. In addition, an active component can be mixed with the binder formulation and water to produce a seed treatment mixture. As used herein, the term "seed treatment mixture" refers to the slurry that is actually applied to seeds in a seed treatment process.

In one embodiment, seed treatment mixtures comprise an active component and a binder formulation including a latex carrier, a wax and mica. The binder formulation and/or the seed treatment mixture optionally also includes other product stabilizing additives. These ingredients when used together provide binder formulations that are storage stable and are suitable for use in normal seed treatment equipment. Seeds treated with the seed treatment mixtures have good flowability and dust-off characteristics.

Further embodiments, forms, features, advantages, aspects, and benefits shall become apparent from the following descriptions.
DETAILED DESCRIPTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to various embodiments and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications in the described embodiments, and any further applications of the principles of the invention as described herein are contemplated as would normally occur to one skilled in the art to which the invention relates.

The present application relates to a discovery that certain combinations of ingredients when used together provide binder formulations having surprisingly advantageous features, including producing treated seeds having advantageous flowability characteristics, low dust-off characteristics and advantageous plantability characteristics, while effectively binding an active ingredient to the treated seeds. Moreover, the aqueous seed treatment binder formulations provided herein are storage stable and are suitable for use in normal seed treatment equipment.

In one aspect, the present application provides a binder formulation that includes a latex carrier, a wax and mica. In another aspect, the application provides a seed treatment mixture that includes a binder formulation as described herein, an agricultural active component and water. The agricultural active component includes at least one agricultural active ingredient. Binder formulations having certain combinations of ingredients as described herein have been made and tested and have been discovered to exhibit surprisingly good properties compared to seeds coated with seed treatment mixtures made using polymer premix products currently in the marketplace, including measurably better flowability characteristics, measurably lower dust-off characteristics and/or measurably better plantability characteristics.

In one embodiment, the latex carrier in the binder formulation comprises a styrene-acrylate based copolymer. The term "latex" as used herein means a dispersion in an aqueous carrier of polymer particles, in this case, particles of a styrene-acrylate based copolymer. In one embodiment, the copolymer includes at
least two of the following comonomers: styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers. In another embodiment, the copolymer includes at least three of the above comonomers. In yet another embodiment, the copolymer includes all four of these comonomers.

In still another embodiment, the copolymer includes from about 1% to about 30% styrene comonomers by weight, from about 50% to about 90% butyl acrylate comonomers by weight, from about 1% to about 25% acrylonitrile comonomers by weight and up to about 20% acrylic acid comonomers by weight. In still yet another embodiment, the copolymer includes from about 5% to about 25% styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and from about 1% to about 10% acrylic acid comonomers by weight. Another embodiment includes from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight, from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight. Yet another embodiment includes from about 13% to about 17% styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid comonomers by weight. Still another embodiment includes about 15% styrene comonomers by weight, about 69% butyl acrylate comonomers by weight, about 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight. In one embodiment, the copolymer is a random copolymer.

The styrene-acrylate based copolymer can be formed by conventional emulsion polymerization. The method for producing styrene-acrylate based resins is not particularly limited and a known method can be adopted. For example, the copolymer can be made by emulsifying a mixture of monomers (in predetermined proportions based upon the desired proportions in the resulting polymer), water, surfactant and polymerization catalyst; charging the resulting emulsion into a conventional polymerization reactor; and heating the constituents in the reactor to about 60-95°C for about 15 minutes to 8 hours. The resulting polymer can then
be neutralized with ammonia or an amine. Styrene-acrylate based copolymers as described herein are also readily available commercially.

In another embodiment, the latex carrier in the binder formulation comprises a styrene-butadiene latex.

As will be appreciated by a person of ordinary skill in the art, a latex carrier as described herein will typically include, in addition to the polymer particles and water, additional ingredients in some amount. For example, the latex carrier may include surfactants and catalysts that are not removed following the polymerization reaction. In addition, the latex can also include other additives. In addition, various amounts of water can be included in the latex carrier. As such, various latexes made or obtained commercially can have varying amounts of polymer solids relative to the total amount of the latex carrier. In one embodiment, the latex carrier includes from about 30% to about 70% polymer solids. In another embodiment, the latex carrier includes from about 40% to about 60% polymer solids. In yet another embodiment, the latex carrier includes from about 45% to about 50% polymer solids. For purposes of describing various binder formulations herein, the weight percent values for the latex carrier are based upon the weight of the latex carrier component as supplied. The term "as supplied" is used to refer to the total weight of a given latex carrier ingredient, including the polymer particles, water and other ingredients therein.

In one embodiment, the copolymer particles have an average particle size of from less than 100 nanometers (nm) to about 400 nm. In another embodiment, the average particle size is from about 100 nm to about 200 nm. In yet another embodiment, the weight average molecular weight is from about 500 g/mol to about 3Mg/mol. The molecular weight can be measured, for example, by gel permeation chromatography using polystyrene as the standard. Particle size can be measured, for example, by dynamic light scattering.

In one embodiment, the latex carrier (which includes an aqueous suspension of polymer particles) comprises from about 5% to about 50% by weight of the binder formulation. In another embodiment, the latex carrier comprises from about 5% to about 40% by weight of the binder formulation. In yet another embodiment, the latex carrier comprises from about 10% to about
30% by weight of the binder formulation. In still another embodiment, the latex carrier comprises from about 15% to about 25% by weight of the binder formulation. The polymer solids of the latex carrier in various embodiments are from about 2% to about 35% by weight of the binder formulation, from about 3% to about 30% by weight of the binder formulation, from about 5% to about 25% by weight of the binder formulation and about 8% to about 20% by weight of the binder formulation.

The binder formulation also includes a wax. The wax can be, for example, natural wax (e.g., beeswax or lanolin), vegetable wax (e.g., Carnauba), mineral wax (e.g., montan or paraffin), synthetic wax (e.g., polyethylene (polar or nonpolar), polypropylene, Fischer-Tropsch, or polybutene), or another lubricant such as, for example, polytetrafluoroethylene. In one embodiment, the wax is a synthetic wax. In another embodiment, the wax is polyethylene wax. A representative polyethylene wax product that can be employed in the binder formulations described herein is the product named Liquitron 461, which is commercially available from Lubrizol Advanced Materials, Inc. (McCook, Illinois). As with the latex carrier, a synthetic wax will typically include, in addition to the wax solids themselves, additional ingredients in some amount. For example, the wax ingredient may include surfactants, stabilizers and preservatives. In one embodiment, the wax ingredient comprises from about 2% to about 40% by weight of the binder formulation. In another embodiment, the wax ingredient comprises from about 5% to about 35% by weight of the binder formulation. In yet another embodiment, the wax ingredient comprises from about 10% to about 35% by weight of the binder formulation. In still another embodiment, the wax ingredient comprises from about 15% to about 30% by weight of the binder formulation. In alternative embodiments, wax solids in various embodiments comprise from about 2% to about 40% by weight of the binder formulation, from about 5% to about 35% by weight of the binder formulation, from about 10% to about 35% by weight of the binder formulation and about 15% to about 30% by weight of the binder formulation.

The binder formulation also includes particulate mica. In one embodiment, the mica comprises micronized mica. A representative mica product
that can be employed in the seed treatment formulations described herein is the product named Mica C-4000, which is commercially available from Darwin Chemical Company (Plantation, Florida). In one embodiment, the mica comprises from about 2% to about 25% by weight of the binder formulation. In another embodiment, the mica comprises from about 4% to about 20% by weight of the binder formulation. In yet another embodiment, the mica comprises from about 5% to about 15% by weight of the binder formulation. In still another embodiment, the mica comprises from about 8% to about 12% by weight of the binder formulation.

In the present application, an "active ingredient" is a compound that directly exerts a biologically relevant effect. In one embodiment, the active ingredient exerts a pesticidal effect. In alternative embodiments, the active ingredient can have one or more other effects instead of, or in addition to, a pesticidal effect. For example, the active ingredient may function to provide nutrition or control one or more plant diseases.

In one embodiment, the active ingredient comprises a plant pesticide. As used herein, the term "pesticide" is used to refer to an agent that has the purpose or effect of preventing infection of a plant by any pest or of repelling, deterring or destroying the pest or of reducing in another way the damage caused by it. Plant pests can belong to different groups of organisms; the higher animals, in particular insects and acarids, include numerous important pests, as do nematodes and snails; vertebrates, such as mammals and birds, are today of secondary importance in industrialized countries. Numerous groups of microbes, including fungi, bacteria, inclusive of mycoplasmas, viruses and viroids, comprise pests, and even weeds, which compete with useful plants for limited habitat and other resources, can be classed as pests in the broad sense. Pesticides comprise in particular aphicides, acaricides, desiccants, bactericides, chemosterilants, defoliants, antifeedants, fungicides, herbicides, herbicide safeners, insect attractants, insecticides, insect repellents, mollusccides, nematicides, mating disrupters, plant activators, plant growth regulators, rodenticides, mammal repellents, synergists, bird repellents and virucides.
In one embodiment, the active ingredient is effective to protect the seed
and/or the resulting plant against diseases in the soil, which mostly occur in the
early stages of plant development. For example and without limitation, the active
ingredient can be formulated to target pathogens including Pythium, Tilletia,
Gerlachia, Septoria, Ustilago, Fusarium, Rhizoctonia (so-called "damping off
complex"); Oomycetes such as Phytophthora, Plasmopara, Pseudoperonospora,
Bremia etc. as well as against the Botrytis species, Pyrenophora, Monilinia and
further representatives of the Ascomycetes, Deuteromycetes and Basidiomycetes
classes.

The following list of pesticides which can be used in a seed treatment
mixture as described herein is intended to illustrate possible active ingredients,
but not to impose any limitation:

   Typical fungicidal ingredients include Captan (N-trichloromethyl)thio-4-
cyclohexane-1,2-dicarboximide), Thiram (tetramethylthioperoxycarboximide
diamide; commercially available under the tradename Proseed), Metalaxyl
(methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-DL-alaninate), Fludioxonil
(4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1-H-pyrrol-3-carbonitril; commercially
available in a blend with mefenoxam under the tradename Maxim XL),
difenconazole (commercially available under the tradename Dividend 3FS),
carbendazim iprodione (commercially available under the tradename
Rovral. RTM.), ipconazole, mefenoxam (commercially available under the
tradename Apron XL), tebuconazole, carboxin, thiabendazole, azoxystrobin,
prochloraz, and Oxadixyl (N-(2,6-dimethylphenyl)-2-methoxy-N-(2-oxo-3-
oxazolidinyl) acetamide).

   Typical bactericidal ingredients include streptomycin, penicillins,
tetracyclines, ampicillin, and oxolinic acid.

   Typical insecticidal ingredients include pyrethroids, organophosphates,
caramoyloximes, pyrazoles, amidines, halogenated hydrocarbons, neonicotinoids,
and carbamates and derivatives thereof. Particularly suitable classes of
insecticides include organophosphates, phenylpyrazoles and pyrethroids. Preferred
insecticides are those known as terbufos, chlorpyrifos, fipronil, chlorethoxyfos,
tefluthrin, carbofuran, imidacloprid, and tebupirimfos. Commercially available
insecticides include imidacloprid (commercially available under the tradename Gaucho™), and clothianidin (commercially available from Bayer under the tradename Poncho®), thiomethoxam (commercially available from Syngenta under the tradename Cruiser®) and fipronil (commercially available from BASF under the tradename Regent®).

Commercially available nematicidal ingredients include abamectin (commercially available from Syngenta under the tradename Avicta®) thiodicarb (commercially available from Bayer under the tradename Aaris®).

In one embodiment, the active component of the seed treatment mixture includes at least one fungicidal ingredient. Fungicidal ingredients are employed in a fungicidally effective amount in the mixture. One representative fungicide that can be employed is Maxim Quattro, which is commercially available from Syngenta. The fungicidal ingredient can be included in the seed treatment mixture, for example, in an amount of from about 1% to about 60% by weight, based on the total weight of the seed treatment mixture.

Mixtures of one or more of the foregoing fungicidally active compounds also are usable together as an active component in the seed treatment mixture. In one embodiment, mixtures of at least one ambient liquid fungicide (for example, a phenylamide, such as R-metalaxyl) and at least one ambient solid fungicide (for example, a phenylpyrrole such as fludioxonil) are employed.

In another embodiment, the active component in the seed treatment mixture includes at least one insecticidal ingredient. Insecticidal ingredients are employed in an insecticidally effective amount in the formulation. One representative insecticide that can be employed is Cruiser 5FS, which is commercially available from Syngenta. The insecticide can be included in the seed treatment mixture, for example, in an amount of 1% to about 60% by weight, based on the total weight of the seed treatment mixture.

In yet another embodiment, the active component includes both a fungicidal ingredient and an insecticidal ingredient. In another embodiment, the active component includes at least one fungicidal ingredient, at least one insecticidal ingredient and at least one nematicidal ingredient, which can be incorporated as individual ingredients or as pre-mixed ingredients. For example,
the commercial product Avicta Duo 300 is a combination nematicide/insecticide product that can be employed to provide these ingredients for the active component. In yet another embodiment the active component further includes other active ingredients.

As will be appreciated by a person of ordinary skill in the art, an active component as described herein, which can include one active ingredient or a mixture of active ingredients, may include, in addition to the one or more active ingredients, additional non-active ingredients in some amount. For example, the active component may include surfactants, solvents (e.g., water and/or other solvents), an antifreeze ingredient, a thickener, an antifoam ingredient, a preservative, a colorant, or other additives. As such, various active components made or obtained commercially can have varying amounts of active ingredients relative to the other, non-active, ingredients in the active component, including a wide variety of diluted forms, all of which are included within the meaning of the term "active component" herein. For purposes of describing various seed treatment mixtures herein, the weight percent values for the active component are based upon the weight of the active component as supplied. The term "as supplied" is used to refer to the total weight of a given active component, including the active ingredients and any non-active ingredients that may be present therein.

The exact amount of an active ingredient included in the seed treatment mixture can vary depending upon the size and other characteristics (e.g., surface structure, etc.) of the seed to be coated and other considerations. The active component of the seed treatment formulation should not inhibit germination of the seed and should be efficacious in protecting the seed and/or the plant during that time in the target pest's life cycle in which it causes injury to the seed or plant. In one embodiment, the seed treatment mixture applied to a seed is operable to form a coating having an active ingredient therein that remains efficacious for up to about 120 days after sowing. In another embodiment, the coating applied to a seed is operable to remain efficacious for up to about 60 days after sowing.

The seed treatment mixture can also comprise or may be applied together and/or sequentially with further active compounds. These further compounds can
be fertilizers or micronutrient donors or other preparations that influence plant growth, such as inoculants.

While additional polymers are not needed in the binder formulation, the binder formulation of the present application can include one or more additional polymers so long as the inclusion of the additional binder does not unduly interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. Additional binders that can be included, either alone or in combination, include, for example, polyesters, polyether esters, polyanhydrides, polyester urethanes, polyester amides; polyvinyl acetates; polyvinyl acetate copolymers; polyvinyl alcohols and tylose; polyvinyl alcohol copolymers; polyvinylpyrrolidones; polysaccharides, including starches, modified starches and starch derivatives, dextrins, maltodextrins, alginates, chitosanes and celluloses, cellulose esters, cellulose ethers and cellulose ether esters including ethylcelluloses, methylcelluloses, hydroxymethylcelluloses, hydroxypropylcelluloses and carboxymethylcellulose; fats; oils; proteins, including casein, gelatin and zeins; gum arabics; shellacs; vinylidene chloride and vinylidene chloride copolymers; lignosulfonates, in particular calcium lignosulfonates; polyacrylates, polymethacrylates and acrylic copolymers; polystyrenes, polyethylene oxide; polybutenes, polyisobutenes, polystyrene, polybutadiene, polyethyleneamines, polyethyleneamides; acrylamide polymers and copolymers; polyhydroxyethyl acrylate, methacrylamide monomers; and polychloroprene. Copolymers of the polymers listed above are also envisioned, one suitable example being polystyrene-polybutadiene copolymers.

In one embodiment, the amount of additional binder or combination of binders does not exceed 10% by weight of the binder formulation. In another embodiment, it does not exceed 5% by weight and, in yet another embodiment, 1% by weight, based on the weight of the binder formulation. According to a particular embodiment, the binder formulation does not include significant amounts of additional binders, i.e. they contain no additional binder or the amount is below 0.5% by weight and preferably below 0.1% by weight, based on the weight of the binder formulation.
In addition to latex carrier, a wax and mica, the binder formulations, and thus the seed treatment mixtures, of the present application optionally also include other auxiliary ingredients, such as, for example, any auxiliary ingredient that is customary in agrochemical formulations and does not unduly interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. The selection of auxiliaries to be included can depend on the particular active ingredient selected for inclusion or the type of seed being treated, for example. Examples for suitable auxiliary ingredients include solvents, carriers, protective colloids, organic and inorganic thickeners, preservatives (including bactericides and other biocides), humectants, antifreeze ingredients, antifoam ingredients and if appropriate colorants.

In one embodiment, the binder formulation includes at least one product stabilizing ingredient. In one embodiment, the product stabilizing ingredient is selected from the group consisting of an antifoam ingredient, a thickener, an antifreeze ingredient, a preservative, and combinations thereof. In another embodiment, the binder formulation includes a product stabilizing ingredient selected from the group consisting of an antifreeze ingredient, a thickener, an antifoam ingredient and a preservative.

In one embodiment, an antifreeze ingredient is present in the binder formulation at a concentration of from about 1 to about 20% by weight. In another embodiment, the concentration of the antifreeze ingredient in the binder formulation is from about 1 to about 10. Antifreeze ingredients that can be employed in an aqueous composition include those substances which lead to a depression of the melting point of water. Suitable antifreeze ingredients include, for example and without limitation, ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, 1,2-butandiol, 1,3-butandiol, 1,4-butandiol, 1,4-pentanediol, 3-methyl-1,5-pentanediol, 2,3-dimethyl-2,3-butanediol, trimethylol propane, mannitol, sorbitol, glycerol, pentaerythritol, 1,4-cyclohexanediethanol, xylenol, bisphenols such as bisphenol A or the like. In addition, ether alcohols such as diethylene glycol, triethylene glycol, tetraethylene glycol, polyoxyethylene or polyoxypropylene glycols of molecular weight up to about 4000, diethylene glycol monomethylether, diethylene glycol monoethylether, triethylene glycol
monomethylether, butoxyethanol, butylene glycol monobutylether, dipentaerythritol, tripentaerythritol, tetrapttaerythritol, diglycerol, triglycerol, tetruglycerol, pentaglycerol, hexaglycerol, heptaglycerol, octaglycerol and combinations thereof.

In one embodiment, a thickener is present in the binder formulation in an amount of from about 1 to about 25% by weight. In another embodiment, the amount of the thickener in the binder formulation is from about 1 to about 10% by weight. The term "thickener" is used herein to refer to compounds that impart a modified flowability to formulations, including, for example, certain viscosity characteristics. In one embodiment the thickener is a compound that imparts an increased viscosity under static conditions and a lower viscosity during agitation.

Examples of suitable thickeners include polysaccharides and organic and inorganic clays. In one embodiment, the thickener is a water-soluble polymer that exhibits pseudoplastic properties in an aqueous medium, such as, for example, gum arabic, gum karaya, gum tragacanth, guar gum, locust bean gum, xanthan gum, carrageenan, alginate salt, casein, dextran, pectin, agar, 2-hydroxyethyl starch, 2-aminoethyl starch, 2-hydroxy ethyl cellulose, methyl cellulose, carboxymethyl cellulose salt, cellulose sulfate salt, polyacrylamide, alkali metal salts of the maleic anhydride copolymers, alkali metal salts of poly(meth)acrylate, and the like. This list is not intended to be exhaustive, however, and a wide variety of other thickeners can be employed. A wide variety of thickeners are available commercially, including, for example, the following: Kelzan® (CP Kelco, U.S.A.), Rhodopol® 23 (Rhodia, France), Veegum® (R.T. Vanderbilt, U.S.A.) or Attaclay® (Engelhard Corp., NJ, USA).

In one embodiment, an antifoam ingredient is present in the binder formulation in an amount up to about 2% by weight. In another embodiment, an antifoam ingredient is present in an amount of from about 0.01 to about 1% by weight. Antifoam ingredients that can be employed include those substances that inhibit the development of foam, a variety of which are conventionally used for formulating agrochemical active ingredients. Examples of antifoam ingredients that can be employed include silicone emulsions (such as e.g. Silikon® SRE, Wacker, Germany or Rhodorsil®, Rhodia, France), long chain alcohols, fatty...
acids, salts of fatty acids, fluoroorganic compounds and mixtures thereof. For example, suitable anti-foaming ingredients include polyethylene glycol, glycerine, mineral oil defoamers, silicone defoamers, non-silicone defoamers (such as polyethers, polyacrylates), dimethylpolysiloxanes (silicone oils), arylalkyd modified polysiloxanes, and polyether siloxane copolymer containing fumed silica. Silicone antifoam emulsions are particularly suitable and are included as the antifoam ingredient in one embodiment. In another embodiment, the antifoam ingredient comprises magnesium stearate.

One or more preservatives (e.g., antimicrobial agents or other biocidal agents) may also be included for preservation and stabilization of the binder formulation. In one embodiment, a preservative is present in the binder formulation in an amount up to about 2% by weight. In another embodiment, a preservative is present in an amount of from about 0.01 to about 1% by weight. Examples of suitable bactericides include those based on dichlorophene and benzylalcohol hemi formal (Proxel® from ICI or Acticide® RS from Thor Chemie and Kathon® MK from Dow Chemical) and isothiazolinone derivatives such as alkylisothiazolinones and benzisothiazolinones (Acticide® MBS from Thor Chemie). As further examples, suitable preservatives include MIT (2-methyl-4-isothiazolin-3-one), BIT (1,2-benzisothiazolin-3-one, which can be obtained from Avecia, Inc. as Proxel GXL as a solution in sodium hydroxide and dipropylene glycol), 5-chloro-2-(4-chlorobenzyl)-3(2H)-isothiazolone, 5-chloro-2-methyl-2H-isothiazol-3-one, 5-chloro-2-methyl-2H-isothiazol-3-one, 5-chloro-2-methyl-2H-isothiazol-3-one-hydrochloride, 4,5-dichloro-2-cyclohexyl-4-isothiazolin-3-one, 4,5-dichloro-2-octyl-2H-isothiazol-3-one, 2-methyl-2H-isothiazol-3-one, 2-methyl-2H-isothiazol-3-one-calcium chloride complex, 2-octyl-2H-isothiazol-3-one and benzyl alcohol hemiformal.

In other embodiments, additional ingredients can be included in a binder formulation as described herein. Examples of additional ingredients include humectants, colorants and the like.

In an embodiment including a colorant, the colorant can be included in the binder formulation, which can be diluted and used alone as a seed treatment mixture or can be subsequently mixed with an active component to form a seed treatment mixture.
treatment mixture. Alternatively, a colorant can be mixed with the active component prior to combination with the binder formulation, or can be added to a mixer with the binder formulation and active component as an independent ingredient used to make a seed treatment mixture. Of course, in alternative embodiments, the colorant can be omitted entirely. One advantage of having a colorant (also referred to as a "coloring ingredient"), such as a dye or pigment (and the like such as described in the CFR 180.1001) included in the seed treatment mixture is so that an observer can immediately determine that the seeds are treated. Another potential advantage is that a color coding system can be employed to convey information regarding the specific type of coating present on a treated seed. A dye can also be useful to indicate to the user the degree of uniformity of the coating applied.

Colorants that can be employed in a seed treatment mixture as described herein include a wide variety of dyes and pigments that are conventionally used for such purposes, and that do not interfere with the flowability, dust-off and plantability characteristics of a coated seed made using the formulation. In this context, both pigments, which are sparingly soluble in water, and dyes, which are soluble in water, may be used. Examples of colorants (i.e. dyes and pigments) that can be employed include those known under the names Rhodamin B, C. 1, Pigment Red 112 and C. 1, Solvent Red 1, Pigment Blue 15:4, Pigment Blue 15:3, Pigment Blue 15:2, Pigment Blue 15:1, Pigment Blue 80, Pigment Yellow 1, Pigment Yellow 13, Pigment Red 48:2, Pigment Red 48:1, Pigment Red 57:1, Pigment Red 53:1, Pigment Orange 43, Pigment Orange 34, Pigment Orange 5, Pigment Green 36, Pigment Green 7, Pigment White 6, Pigment Brown 25, Basic Violet 10, Basic Violet 49, Acid Red 51, Acid Red 52, Acid Red 14, Acid Blue 9, Acid Yellow 23, Basic Red 10, Basic Red 108. In one embodiment, a colorant is used that is also active as repellents for warm-blooded animals. Examples of such colorants include iron oxide, TiO₂, Prussian blue, anthraquinone dyes, azo dyes and metal phthalocyanine dyes. This list is provided only to set forth some examples of colorants that can be employed, it being understood that a wide variety of alternative colorants are known and available commercially that can be
included as alternatives to, or in addition to, the above, and such are expressly contemplated by the present application.

In one embodiment, the amount of colorant (including individual colorants or combinations of colorants) is from 0% to about 30% by weight of the binder formulation or of the seed treatment mixture. In another embodiment, the amount of colorant is from 0 to about 10% by weight of the binder formulation or of the seed treatment mixture.

While various product stabilizing ingredients can be included in the binder formulation, the inventors have also discovered that certain ingredients that are commonly included in other agrochemical formulations, and that are often described as stabilizers, have adverse effects on the flowability, dust-off and/or plantability characteristics or are otherwise preferably omitted from the binder formulations and seed treatment mixtures described herein.

In one embodiment, the binder formulation or the seed treatment mixture is substantially free from added emulsifiers, surfactants and other wetters or dispersants. As used in the preceding sentence, the term "added" means that the identified materials are not added to the binder formulation or the seed treatment mixture as an ingredient. It is understood, however, that some quantities of one or more of these materials may be present in other ingredients, and that such quantities are not considered "added" ingredients as that term is used herein. For example, it is expected that a latex carrier ingredient included in the binder formulation, and possibly the wax or other ingredient included in a binder formulation or seed treatment mixture described herein, may include some amount of one or more emulsifier, surfactant or other wetter or dispersant as a part of that ingredient. These amounts that are included in other ingredients are not considered "added emulsifiers, surfactants and other wetters or dispersants" as defined herein. In addition, the term "substantially free from" does not mean that the identified ingredients are necessarily completely absent from the binder formulation or seed treatment mixture, but rather that such ingredients are not added in large enough quantities to materially affect the flowability, dust-off and/or plantability characteristics of a coated seed made using the binder formulation or seed treatment mixture. In one embodiment, the binder
formulation includes less than 1% of added emulsifiers, surfactants and other wetters or dispersants by weight. In another embodiment, the binder formulation includes less than 0.5% of added emulsifiers, surfactants and other wetters or dispersants by weight.

In another embodiment, the binder formulation or the seed treatment mixture is substantially free from added talc. The term "added" as used here has the same meaning as described in the preceding paragraph. In addition, the term "substantially free from" in this context does not mean that the binder formulation or the seed treatment mixture must necessarily be completely free of talc, but rather that talc is not added in large enough quantity to materially affect the flowability, dust-off and/or plantability characteristics of the binder formulation or the seed treatment mixture. In one embodiment, the binder formulation includes less than 1% of added talc by weight. In another embodiment, the binder formulation includes less than 0.5% of added talc by weight.

The binder formulation embodiments described above can be diluted with water to provide a diluted binder formulation that is itself used as a seed treatment mixture, i.e., to provide a coating on a seed that has good flowability, low dust-off and good plantability features. Coating with a diluted binder formulation (i.e., without an added active component) may be desired, for example, in the case of a seed that is so small or irregularly shaped that it would benefit from having a coating provided thereon to increase the overall mass of the seed or otherwise improve the physical properties of the seed for more uniform planting. Coating with a diluted binder formulation (i.e., without an added active component) may also be desired, for example, to provide an over-coating on a seed that has previously been treated with an active ingredient or a prior coating of some kind that has poor characteristics, i.e., poorer flowability or plantability characteristics and/or poorer dust-off characteristics. In this embodiment, the previously treated seed can be enveloped with an over-coating comprising a binder formulation as described herein. Thus, in one embodiment, the binder formulation is itself used as a seed treatment mixture, either in an initially prepared form or in a more diluted form.
In another embodiment, the binder formulation is combined with an agricultural active component, water and optionally other ingredients, such as colorants, to provide a seed treatment mixture usable in a seed treatment process. As will be appreciated by a person skilled in the art, because the proportions of ingredients (i.e., weight percentages and weight percent ranges) described above in connection with a binder formulation relate only to the binder formulation component of a seed treatment mixture, the ingredients in the binder formulation will become diluted when the binder formulation is combined with an active component and/or other components and/or additional water. The amount of the active component that is included in the seed treatment mixture can vary depending upon the type of seed, the desired amount of active ingredient loading per seed and other considerations. In one embodiment, the amount of active component included in the seed treatment mixture is based on an amount of the active ingredient or ingredients necessary to be pesticidally effective when present in a seed coating. One advantage of the binder formulations described herein is that they are capable of binding a significant amount of an active component to a seed when blended therewith. In one embodiment, a seed treatment mixture includes from about 20% to about 70% by weight of an active component and from about 20% to about 60% by weight of a binder formulation as described herein, with the balance, if any, including water and optionally other ingredients. In another embodiment, a seed treatment formulation includes from about 30% to about 60% by weight of an active component and from about 25% to about 45% by weight of a binder formulation. These weight percent values are based on the "as added" amounts of the active component and binder formulation, respectively. As discussed above, these components can, and typically do, include various amounts of solvents and other formulay ingredients.

In one embodiment, the viscosity of the binder formulation is from about 50 to about 2000 mPas when measured with a BROOKFIELD viscometer with spindle 3 at 30 rpm and 25 °C. In another embodiment, the viscosity is from about 100 to about 1000 mPas. In one embodiment, a binder formulation as described herein is stable and maintains its viscosity and homogeneity within desirable parameters for at least 12 months at 25° C.
In one embodiment, a seed treatment mixture includes from about 30% to about 60% by weight of an active component comprising a fungicide and a pesticide; from about 30% to about 40% by weight of a binder formulation; from about 1% to about 2% by weight of a colorant; and from about 0% to about 50% by weight of added water. In one embodiment, the pesticide portion of the active component comprises from about 35% to about 55% of the seed treatment formulation and the fungicide portion comprises from about 2% to about 10% of the seed treatment mixture. In one embodiment, the pesticide is a combination of a nematicide, an insecticide and a fungicide. For example and without limitation, the nematicide and insecticide can be provided in the form of the commercial product Avicta Duo, which is a mixture of abamectin and thiamethoxam commercially available from Syngenta, and the fungicide can be provided in the form of the commercial product Maxim Quattro, which is a mixture of mefenoxam, fludioxonil, azoxystrobin and thiabendazole commercially available from Syngenta.

In one embodiment, the binder formulation includes from about 15% to about 25% by weight of a latex (as added, including, e.g., about 40% to 50% solids) comprising a styrene-acrylate based copolymer; from about 15% to about 30% by weight of a polyethylene wax; and from about 5% to about 15% by weight of mica. A suitable polyethylene wax, for example, is the commercial product Liquitron 461, which is commercially available from Lubrizol Advanced Materials, Inc. (McCook, Illinois). In one embodiment, the polyethylene wax is substantially free from alkyl phenol ethoxylates (APE). A suitable mica, for example, is the commercial product Mica C4000, which is commercially available from Darwin Chemical Company (Plantation, Florida). In another embodiment, the binder formulation includes from about 15% to about 25% by weight of a latex (as added) comprising styrene butadiene; from about 15% to about 30% by weight of a polyethylene wax; and from about 5% to about 15% by weight of mica.

In another embodiment, the binder formulation further includes from about 2% to about 6% propylene glycol; from about 8% to about 14% xanthan gum gel (about 2% solids); from about 1% to about 3% attapulgite clay; from
about 0.01 to about 0.1% silicone emulsion (such as, for example, Antifoam 1500, which is commercially available from Dow Corning, Midland, Michigan); and from about 0.02% to about 0.15% 1,2-benzisothiazolin-3-one in glycol (such as, for example, Proxel GXL, which is commercially available from Avecia, Inc.). In another embodiment, the binder formulation further includes from about 0% to about 40% of added water.

The binder formulation can be prepared by blending the various ingredients together. In one manner of making a binder formulation embodiment, a first component is prepared by introducing a predetermined amount of the antifreeze ingredient and a predetermined amount of the antifoam ingredient into a 3-pronged mixer and mixed at 500 rpm for five minutes, followed by 750 rpm for 5 minutes to provide a first component. (Each "predetermined amount" is based upon the desired ratios in the final binder formulation). A second component is made by introducing a predetermined amount of the thickener and a predetermined amount of the preservative into a 3-pronged mixer and mixed at 500 rpm for five minutes. The first component is then introduced, together with a predetermined amount of a mica slurry and a predetermined amount of water, into a Caframo High Speed Mixer and mixed using a Cowels blade at 1500 rpm for five minutes. A predetermined amount of the wax is then added to the contents of the Caframo Mixer and the resulting mixture is again mixed using a paddle mixing blade. The second component and a predetermined amount of the latex carrier, together with predetermined amounts of any other ingredients to be included in the binder formulation, are then added to the contents of the Caframo High Speed Mixer, and the resulting mixture is then mixed with a 3-pronged mixer at 500 rpm for five minutes to provide a binder formulation.

The binder formulation can then be used individually (i.e., after dilution with water) for coating seeds, or can be further blended with a predetermined amount of an active component, water, and optionally a colorant, to provide a seed treatment mixture. The seed treatment mixture can be prepared immediately following preparation of the binder formulation or, alternatively, the binder formulation can be stored, or optionally packaged and shipped, for future use in preparing a seed treatment mixture. For example, the blending of the binder
formulation with the active component can be done immediately prior to application of the seed treatment formulation to seeds.

In one embodiment, the binder formulation can be provided in the form of a re-dispersible solids mixture of the binder formulation ingredients. A seed treatment mixture can be made using this type of binder formulation by diluting the solids mixture with water, and optionally with an active component and/or a colorant, prior to application to seeds. This embodiment can be advantageous, for example, in situations where the application of a seed treatment mixture to seeds does not occur at the same location as the manufacture of the binder formulation. Due to the need for shipment or transportation of the binder formulation to the location of application, the lower volume and mass of the re-dispersible solids mixture reduces the cost of such transportation. At the location where the formulation is to be applied to seeds, water, and optionally other ingredients to be included in the seed treatment mixture, can be mixed with the re-dispersible solids mixture in amounts to provide a seed treatment mixture having desired properties for application to seeds. As will be appreciated by persons skilled in the art in view of the present descriptions, a re-dispersible solids mixture will typically include all non-water ingredients in the same proportions to one another as desired in the final seed treatment mixture.

The seed treatment formulation can be applied to a seed in a variety of manners conventional in the seed treating art, including but not limited to mixing in a container (e.g., a bottle, bag or tumbler), mechanical application, tumbling, spraying, and immersion, followed by drying. Examples of seed coating techniques and machines that can be employed include fluidized bed techniques, the roller mill method, rotary seed treaters, drum coaters, side vended pan, tumble mixers and spouted beds. The seeds may be pre-sized before coating. In one embodiment, the seed treatment mixture is applied to seeds in a Hege seed treater, which rotates as the formulation is being added to the seeds. Mixing is preferably continued until the seed treatment formulation is distributed uniformly on the seed (i.e., uniform coatings over all of the seeds to be treated and an even coating on each individual seed). The seed treatment mixture can be applied to seeds in a batch treatment process or in a continuous treatment process.
representative batch treatment process, the seeds to be treated are introduced to a batch treatment tank and the seed treatment mixture is then added and mixed with the seeds. Alternatively a continuous treatment process can be used to apply the seed treatment mixture to seeds in which a stream of seeds are introduced into a receptacle containing the seed treatment slurry and, after contacting the formulation, recovered from the receptacle for drying. A stream of seed treatment mixture can continuously flow into the receptacle as well to replenish quantities of the mixture that are removed with treated seeds.

After application of the seed treatment mixture (whether in a batch process or a continuous process) the seeds are allowed a period of time to dry. For example, the seeds can be spun in a bowl for a period of time, for example, at least 15 seconds, to allow for drying. Different time periods may be needed to allow for variability in drying conditions due to weather or different seed sizes. Moreover, heat can be provided, if desired, to increase drying times, for example, in the form of a heated stream of air. After drying, the coated seeds can undergo a size separation or classification process.

As used herein, the term "seed" denotes any resting stage of a plant that is physically detached from the vegetative stage of a plant and/or may be stored for prolonged periods of time and/or can be used to re-grow another plant individual of the same species. Here, the term "resting" refers to a state wherein the plant retains viability, within reasonable limits, in spite of the absence of light, water and/or nutrients essential for the vegetative (i.e. non-seed) state. In particular, the term refers to true seeds but does not embrace plant propagules such as suckers, corms, bulbs, fruit, tubers, grains, cuttings and cut shoots.

In one embodiment, the seeds treated as described herein include seeds of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, millet varieties such as sorghum, sun flowers, beans, peas, oil plants such as canola, rape, soybeans, cabbages, tomatoes, eggplants (aubergines), pepper and other vegetables and spices as well as ornamental shrubs and flowers. Suitable target crops also include transgenic crop plants of the foregoing. In one embodiment, the seed is from corn, wheat, barley, soybeans, or rape.
Although the seed treatment methods described herein can be applied to a seed in any physiological state, it is preferred that the seed be in a sufficiently durable state that it incurs no significant damage during the treatment process. Typically, the seed is a seed that has been harvested from a field; removed from the plant; and/or separated from the fruit and any cob, pod, stalk, outer husk, and surrounding pulp or other non-seed plant material. The seed is preferably also biologically stable to the extent that the treatment would cause no biological damage to the seed. In one embodiment, for example, the treatment can be applied to seed that has been harvested, cleaned and dried to a moisture content below about 15% by weight. In an alternative embodiment, the seed can be one that has been dried and then primed with water and/or another material and then re-dried before or during the treatment with a seed treatment mixture as described herein. In one embodiment, the seed to be treated is thus substantially dry. "Substantially dry" is used herein to refer to a seed that has a moisture content which results if the seed is allowed to equilibrate in an air atmosphere at 20 to 30°C and 30-90% relative humidity, e.g. at 25°C and 50% relative humidity.

The seed treatment mixture can be applied to the seed at any time from the harvest of the seed to the sowing of the seed in the ground for the purpose of germination and growth of the plant. For example, the treatment may be carried out several weeks or months, for example up to 12 months, before planting the seed, for example in the form of a seed dressing treatment, without a substantially reduced efficacy being observed. Seeds can be treated, for example, at a central location and then dispersed for planting. This permits the person who plants the seeds to avoid the handling and use of active ingredients and to merely handle and plant the treated seeds in a manner that is conventional for regular untreated seeds, which reduces human exposure.

In yet a further aspect, the present application is directed to a coated seed comprising a seed and a coating, which coating comprises a styrene-acrylate based copolymer, a wax and mica, and optionally also includes one or more active ingredient and/or additional stabilizing ingredient. Such a coated seed may be prepared using the seed treatment mixtures described herein. The coated seeds advantageously exhibit favorable surface properties that impart good flowability,
plantability and dust-off characteristics. In another aspect, a coated seed
comprises a seed and a coating, which coating comprises styrene-butadiene, a
wax and mica, and optionally also includes one or more active ingredient and/or
additional stabilizing ingredient.

One excellent feature of the seed treatment mixtures described herein is
that they are effective to make coated seeds with substantially decreased
dustiness, which has the effect of reducing or eliminating related dust problems,
while also increasing flowability, which reduces the problems associated with
seed bridging in seed handling equipment, such as those including hopper-type
features. Substantial reduction or elimination of the dust problem eliminates the
associated health hazards to those who work with treated seeds, such as
processing plant employees, truck drivers, warehouse workers, and farmers.
Substantial reduction or elimination of seed bridging overcomes a number of
problems associated with the tendency of coated seeds to stick together during
storage or during handling operations, such as, for example, removal from storage
the seeds at the bottom of a hopper-style storage container, including delays,
inconveniences and hazards associated with same.

As will be appreciated by a person skilled in the art in view of the above
descriptions, in one aspect of the present application, there is provided an aqueous
seed treatment mixture that includes: (i) from about 1% to about 70% of an
agricultural active component by weight; and (ii) from about 25% to about 45%
of a binder formulation by weight. The binder formulation includes: (a) from
about 5% to about 50% of a latex carrier by weight; (b) from about 1% to about
40% of a wax by weight; and (c) from about 2% to about 25% of mica by weight.
In one embodiment, the latex carrier comprises a styrene-acrylate based
copolymer. In another embodiment, the latex carrier comprises styrene-
butadiene. In one embodiment, the seed treatment formulation comprises from
about 30% to about 40% of said binder formulation by weight.

In one embodiment of the seed treatment mixture, the binder formulation
includes: (a) from about 10% to about 40% of a latex carrier by weight; (b) from
about 10% to about 40% of a wax by weight; and (c) from about 4% to about 16%
of mica by weight. In another embodiment, the binder formulation includes: (a)
from about 15% to about 25% of a latex carrier by weight; (b) from about 15% to about 30% of a wax by weight; and (c) from about 6% to about 14% of mica by weight. In yet another embodiment, the binder formulation includes: (a) from about 18% to about 24% of a latex carrier by weight; (b) from about 18% to about 26% of a wax by weight; and (c) from about 8% to about 12% of mica by weight.

In still another embodiment, the binder formulation further comprises at least one stabilizing ingredient. In still yet another embodiment, the at least one stabilizing ingredient is selected from the group consisting of a colorant, an antifoam ingredient, a thickener, an antifreeze ingredient, a preservative and combinations thereof.

In one embodiment of the seed treatment mixture, the latex carrier comprises from about 30 to about 60% by weight of a styrene-acrylate based copolymer. In another embodiment, the copolymer is a random copolymer comprising styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers. In yet another embodiment, the copolymer comprises from about 5% to about 25% styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and about 1 to about 10% acrylic acid comonomers by weight. In still another embodiment, the copolymer comprises from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight, from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight. In still yet another embodiment, the copolymer comprises from about 13% to about 17% styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid comonomers by weight. In yet still another embodiment, the copolymer comprises about 15% styrene comonomers by weight, about 69% butyl acrylate comonomers by weight, about 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight. In another embodiment, the latex carrier comprises from about 30 to about 60% by weight of
styrene-butadiene. In another embodiment, the copolymer has an average molecular weight of from about 5000 g/mol to about 3 Mg/mol.

In one embodiment, the binder formulation or the seed treatment mixture is substantially free from added emulsifiers, surfactants and other wetters or dispersants. In another embodiment, the binder formulation or the seed treatment mixture is substantially free from talc.

In one embodiment of the seed treatment mixture, the agricultural active component comprises a pesticidal ingredient. In another embodiment, the pesticidal ingredient is selected from the group consisting of an insecticide, a fungicide and combinations thereof.

In one embodiment, the wax is selected from the group consisting of natural wax, vegetable wax, mineral wax and synthetic wax. In another embodiment, the wax comprises polyethylene wax.

In yet another embodiment, the amount of the agricultural active component is from about 40 to about 60% by weight of the total mixture; the amount of the latex carrier is from about 5 to about 10% by weight of the total mixture; the amount of the wax is from about 5 to about 10% by weight of the total mixture; and the amount of the mica is from about 3 to about 4% by weight of the total mixture.

In another aspect of the present application, there is provided a seed treated with a seed treatment mixture embodiment described herein. In one embodiment, the seed is of one of the following plants: corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, sorghum, sun flowers, beans, peas, canola, rape, cabbages, tomatoes, eggplants, peppers, other vegetables and spices, ornamental shrubs and flowers. In another embodiment, the seed has a coating thereon comprising a styrene-acrylate based copolymer, a wax, mica and an agricultural active component. In yet another embodiment, the seed has a coating thereon comprising styrene-butadiene, a wax, mica and an agricultural active component.

In yet another aspect, the present application provides a method for protecting a seed from pests. The method includes applying to a viable seed an effective amount of a seed treatment mixture in accordance with any of the
embodiments described herein. In another embodiment, the method includes: (i) applying a seed treatment mixture as described above onto a seed; and (ii) allowing the mixture applied to the seed to dry to form a coated seed.

In still another aspect of the application, there is provided an aqueous seed treatment mixture that consists essentially of: (i) from about 10% to about 60% of an agricultural active component by weight; and (ii) from about 25% to about 45% of a binder formulation by weight. The binder formulation includes: (a) from about 5% to about 50% of a latex carrier by weight; (b) from about 2% to about 40% of a wax by weight; (c) from about 2% to about 25% of mica by weight; (d) from about 0 to about 1% of an antifoam ingredient by weight; (e) from about 0 to about 30% of a thickener by weight; (f) from about 0 to about 20% of an antifreeze ingredient by weight; (g) from about 0 to about 1% of a biocide by weight; and (h) from about 0 to about 5% of a suspending aid by weight; and (iii) from about 0 to about 3% of a colorant by weight. In one embodiment, the latex carrier comprises a styrene-acrylate based copolymer. In another embodiment, the latex carrier comprises styrene-butadiene.

Reference will now be made to the following Examples, which describe experimental work directed to the subject matter of the present application. It is understood that no limitation to the scope of the application is intended thereby. The Examples are intended to be illustrative, are provided solely to promote a full understanding of the concepts embodied in the application, and are not intended to be limiting or otherwise restrictive as to the nature and scope of the inventions set forth herein.
EXAMPLES

The data set forth below show that coated seeds made using seed treatment mixtures prepared as described in the present application exhibit better overall characteristics involving dust-off, flowability and plantability compared to leading commercially available seed coating materials Incotec L320 and FloRite 1197.

EXAMPLE ONE

Preparation of a Representative Binder Formulation

A binder formulation was made by thoroughly blending the ingredients set forth in Table 1 in the identified proportions.

Table 1

<table>
<thead>
<tr>
<th>Component</th>
<th>Chemical Composition</th>
<th>Nominal Weight Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex carrier (47% polymer solids)</td>
<td>Random copolymer of the following comonomers: styrene (15 wt%), butyl acrylate (69 wt%), acrylonitrile (12 wt%) and acrylic acid (5 wt%)</td>
<td>20.83</td>
</tr>
<tr>
<td>Wax (Liquitron 461)</td>
<td>Polyethylene wax</td>
<td>22.22</td>
</tr>
<tr>
<td>Mica (Mica C4000)</td>
<td>Mica</td>
<td>10.00</td>
</tr>
<tr>
<td>Antifreeze ingredient</td>
<td>Propylene glycol</td>
<td>4.00</td>
</tr>
<tr>
<td>Thickener (xanthan gum gel) (2% solids)</td>
<td>Polysaccharide gum</td>
<td>11.00</td>
</tr>
<tr>
<td>Thickener (Attaflow FL) (21% solids)</td>
<td>Attapulgite clay</td>
<td>2.00</td>
</tr>
<tr>
<td>Antifoam ingredient (Antifoam 1500)</td>
<td>Silicone emulsion</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Preservative | 1,2-benzisothiazolin-3-one in glycol | 0.08  
(Proxel GXL) | |  
Water | Water | 29.81

**EXAMPLE TWO**

Preparation of a Representative Seed Treatment Mixture

A seed treatment mixture was made by thoroughly blending the ingredients set forth in Table 2 in the identified proportions.

<table>
<thead>
<tr>
<th>Component</th>
<th>Nominal Weight Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binder formulation from Example One</td>
<td>35.13</td>
</tr>
<tr>
<td>Pesticide</td>
<td>49.96</td>
</tr>
<tr>
<td>(Avicta Duo 500)</td>
<td></td>
</tr>
<tr>
<td>Fungicide</td>
<td>5.32</td>
</tr>
<tr>
<td>(Maxim Quattro)</td>
<td></td>
</tr>
<tr>
<td>Color coated red</td>
<td>1.64</td>
</tr>
<tr>
<td>Water</td>
<td>7.95</td>
</tr>
</tbody>
</table>

In addition to the seed treatment mixtures prepared as described above, for purposes of comparative testing, two comparative seed treatment mixtures were made using the same procedures as described above; however, in the preparation of the comparative seed treatment mixtures the binder formulation from Example One was replaced with one of two commercial products sold as polymer premixes for seed treatment mixtures, namely, Incotec L320 (commercially available from Incotec) and FloRite 1197 (commercially available from Becker Underwood).

**EXAMPLE THREE**

Application of Seed Treatment Formulation to Seeds

Seeds coated with seed treatment mixtures made as set forth in Example Two were prepared using a Hege seed treater. Each of the three seed treatment
mixtures (i.e., the seed treatment mixture including the binder formulation prepared as described in Example One and the two comparative seed treatment mixtures prepared using the commercial products), was applied to a quantity of corn seeds of each of three corn hybrids, namely, H9014, H6629 and 83X61. The seed treatment mixture was applied to the seeds in an amount effective to provide a coating on each seed in an average amount of about 1.25 mg of coating per seed. Thus, coated seeds having the combinations set forth in Table 3 were prepared.

Table 3

<table>
<thead>
<tr>
<th>Combination No.</th>
<th>Seed Hybrid</th>
<th>Binder Formulation Used in Seed Treatment Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H9014</td>
<td>Binder formulation of Example One</td>
</tr>
<tr>
<td>2</td>
<td>H9014</td>
<td>Incotec L320</td>
</tr>
<tr>
<td>3</td>
<td>H9014</td>
<td>FloRite 1197</td>
</tr>
<tr>
<td>4</td>
<td>H6629</td>
<td>Binder formulation of Example One</td>
</tr>
<tr>
<td>5</td>
<td>H6629</td>
<td>Incotec L320</td>
</tr>
<tr>
<td>6</td>
<td>H6629</td>
<td>FloRite 1197</td>
</tr>
<tr>
<td>7</td>
<td>83X61</td>
<td>Binder formulation of Example One</td>
</tr>
<tr>
<td>8</td>
<td>83X61</td>
<td>Incotec L320</td>
</tr>
<tr>
<td>9</td>
<td>83X61</td>
<td>FloRite 1197</td>
</tr>
</tbody>
</table>

EXAMPLE FOUR

Dust-off Experiments

Each of the combinations described in Example Three was tested to measure the dust-off characteristics of the respective combinations. Dust-off experiments were carried out using a Type I Heubach Dust Meter. A known mass of sample is tumbled at a constant speed and purged with air at a specified flow rate, for a specific time period. Dust produced during this process is carried away by the air stream and collected on a piece of filter. The amount of dust thus
produced is calculated and recorded in grams per 100 kilogram of seed or, in some cases, in milligrams per 200 grams seed. Based on these tests, the dust-off measurements for combinations 1, 4 and 7 were statistically better than the dust-off measurements for combinations 2, 5 and 8 and were statistically the same as the dust-off measurements for combinations 3, 6 and 9.

The data clearly show that seeds coated using a binder formulation of the present application (i.e., combinations 1, 4 and 7) provide a low level of dust-off that is equal to that of seeds coated with a seed treatment mixture including the FloRite 1197 product (i.e., combinations 3, 6 and 9), and superior to that of seeds coated with a seed treatment mixture including the L320 product (i.e., combinations 2, 5 and 8). Thus, seed treatment mixtures prepared using the binder formulation of Example One have dust-off characteristics that are equal to or better than seed treatment mixtures that include currently leading commercial polymer premix products.

EXAMPLE FIVE

Flowability Experiments

Each of the combinations described in Example Three was tested to measure the flowability characteristics of the respective combinations. To quantify the flowability of the seeds of each combination, i.e., the ability of the coated seeds to flow after treatment, the coated seeds are allowed to flow through a funnel equipped with a closable gate. The gate is opened for a predetermined period of time, and then the seeds that flowed through the gate while open is weighed with a balance. The results, set forth in Table 4, include measurements carried out immediately after seed treatment, 5 minutes after treatment, 1 hour after treatment and 24 hours after treatment. Additional batches of the coated seeds were tested only after a 24 hour period (i.e., were allowed to sit without movement for 24 hours after treatment before being tested for flowability). These measurements are provided in Table 4 in the column labeled "24 hr only." As will be appreciated by a person skilled in the art, the greater the weight the better the flowability of the seeds, and so a higher value indicates a better flowability.
Table 4

<table>
<thead>
<tr>
<th>Combination No.</th>
<th>Time 0</th>
<th>5 Minutes</th>
<th>1 Hour</th>
<th>24 Hours</th>
<th>24 hr only</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3835</td>
<td>4154</td>
<td>4610</td>
<td>5112</td>
<td>4832</td>
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<tr>
<td></td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>3647</td>
<td>3919</td>
<td>4620</td>
<td>4998</td>
<td>4982</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>3593</td>
<td>4029</td>
<td>4464</td>
<td>5871</td>
<td>4705</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>3247</td>
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<td></td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>3242</td>
<td>3562</td>
<td>4225</td>
<td>4577</td>
<td>4415</td>
</tr>
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</tr>
<tr>
<td></td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>--</td>
</tr>
<tr>
<td>7</td>
<td>3425</td>
<td>3826</td>
<td>4408</td>
<td>4793</td>
<td>4519</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
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<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

In Table 4, the indicators ++, +, - and ~ are used to identify four groupings of values, with the ++ indicator identifying measurements that exemplify the best flowability results, followed by values identified with the indicator +, followed by values identified with the indicator -, and the measurements exemplifying the lowest flowability are identified with the indicator ~. The data clearly show that seeds coated using a seed treatment mixture made using a binder formulation of the present application (i.e., combinations 1, 4 and 7) exhibit a higher level of overall flowability compared to seeds coated with a seed treatment mixture including the FloRite 1197 product (i.e., combinations 3, 6 and 9) and seeds coated with a seed treatment mixture including the L320 product (i.e., combinations 2, 5 and 8).

**EXAMPLE SIX**

**Plantability Experiments**

Each of the combinations described in Example Three was tested to measure the plantability characteristics of the respective combinations. Conventional techniques for measuring plantability were used. The results of the
Vacuum tests are set forth in Table 5, and the results of the Finger tests are set forth in Table 6.

**Table 5**

<table>
<thead>
<tr>
<th>Combination No.</th>
<th>Slips</th>
<th>Doubles</th>
<th>Seed Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.3</td>
<td>1.6</td>
<td>102.2</td>
</tr>
<tr>
<td>2</td>
<td>0.32</td>
<td>2.6</td>
<td>102</td>
</tr>
<tr>
<td>3</td>
<td>0.2</td>
<td>2</td>
<td>102.7</td>
</tr>
<tr>
<td>4</td>
<td>0.64</td>
<td>3.16</td>
<td>102.9</td>
</tr>
<tr>
<td>5</td>
<td>0.4</td>
<td>2.5</td>
<td>102.3</td>
</tr>
<tr>
<td>6</td>
<td>0.38</td>
<td>3.34</td>
<td>103.2</td>
</tr>
<tr>
<td>7</td>
<td>0.12</td>
<td>2.74</td>
<td>102.8</td>
</tr>
<tr>
<td>8</td>
<td>0.12</td>
<td>3.42</td>
<td>103.5</td>
</tr>
<tr>
<td>9</td>
<td>0.2</td>
<td>2.66</td>
<td>102.7</td>
</tr>
</tbody>
</table>

**Table 6**

<table>
<thead>
<tr>
<th>Combination No.</th>
<th>Slips</th>
<th>Doubles</th>
<th>Seed Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.1</td>
<td>2.2</td>
<td>99.8</td>
</tr>
<tr>
<td>2</td>
<td>1.9</td>
<td>1.9</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>2.5</td>
<td>2</td>
<td>98.2</td>
</tr>
<tr>
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<td>1.4</td>
<td>3</td>
<td>101.5</td>
</tr>
<tr>
<td>5</td>
<td>1.4</td>
<td>2.9</td>
<td>101.5</td>
</tr>
<tr>
<td>6</td>
<td>1.6</td>
<td>1.7</td>
<td>100</td>
</tr>
<tr>
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<td>3.5</td>
<td>102.1</td>
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<tr>
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<td>103.7</td>
</tr>
<tr>
<td>9</td>
<td>1.2</td>
<td>2.6</td>
<td>101.3</td>
</tr>
</tbody>
</table>

While multiple embodiments of the invention have been described in detail in the foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the selected embodiments have been described and that all changes, modifications and equivalents that come within the spirit of the invention as defined herein or by any of the following claims are desired to be protected. Any theory, mechanism of operation, proof, or finding stated herein is meant to further enhance understanding of the present application and is not intended to make the present application in any way dependent upon such theory, mechanism of operation, proof, or finding. It should be understood that any use of the word preferable, preferably or preferred in the description above indicates that the feature so
described may be more desirable, it nonetheless may not be necessary and embodiments lacking the same may be contemplated as within the scope of the invention, that scope being defined by the claims that follow. In reading the claims it is intended that when words such as "a," "an," "at least one," "at least a portion" are used there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. Further, when the language "at least a portion" and/or "a portion" is used the item may include a portion and/or the entire item unless specifically stated to the contrary. All patents, patent applications, and publications references herein are hereby incorporated by reference, each in its entirety.
WHAT IS CLAIMED IS:

1. An aqueous seed treatment formulation comprising:
   from about 1% to about 70% of an agricultural active component by
   weight; and
   from about 25% to about 45% of a binder formulation by weight, said
   binder formulation comprising:
   from about 5% to about 50% of a latex carrier by weight;
   from about 1% to about 40% of a wax by weight; and
   from about 2% to about 25% of mica by weight;
   wherein said latex carrier comprises a styrene-acrylate based copolymer.

2. The formulation in accordance with claim 1 wherein said binder
   formulation comprises:
   from about 10% to about 40% of a latex carrier by weight;
   from about 10% to about 40% of a wax by weight; and
   from about 4% to about 16% of mica by weight.

3. The formulation in accordance with claim 1 wherein said binder
   formulation comprises:
   from about 15% to about 25% of a latex carrier by weight;
   from about 15% to about 30% of a wax by weight; and
   from about 6% to about 14% of mica by weight.

4. The formulation in accordance with claim 1 wherein said binder
   formulation comprises:
   from about 18% to about 24% of a latex carrier by weight;
   from about 18% to about 26% of a wax by weight; and
   from about 8% to about 12% of mica by weight.
5. The formulation in accordance with claim 1 wherein said latex carrier comprises from about 30 to about 60% by weight of said styrene-acrylate based copolymer.

6. The formulation in accordance with claim 1 wherein said formulation comprises from about 30% to about 40% of said binder formulation by weight.

7. The formulation in accordance with claim 1 wherein said copolymer is a random copolymer comprising styrene comonomers, butyl acrylate comonomers, acrylonitrile comonomers and acrylic acid comonomers.

8. The formulation in accordance with claim 7 wherein said copolymer comprises from about 5% to about 25% styrene comonomers by weight, from about 60% to about 80% butyl acrylate comonomers by weight, from about 5% to about 20% acrylonitrile comonomers by weight and about 1 to about 10% acrylic acid comonomers by weight.

9. The formulation in accordance with claim 7 wherein said copolymer comprises from about 10% to about 20% styrene comonomers by weight, from about 64% to about 74% butyl acrylate comonomers by weight, from about 7% to about 17% acrylonitrile comonomers by weight and about 3 to about 7% acrylic acid comonomers by weight.

10. The formulation in accordance with claim 7 wherein said copolymer comprises from about 13% to about 17% styrene comonomers by weight, from about 67% to about 71% butyl acrylate comonomers by weight, from about 9% to about 15% acrylonitrile comonomers by weight and about 4 to about 6% acrylic acid comonomers by weight.

11. The formulation in accordance with claim 7 wherein said copolymer comprises about 15% styrene comonomers by weight, about 69%
butyl acrylate comonomers by weight, about 12% acrylonitrile comonomers by weight and about 5% acrylic acid comonomers by weight.

12. The formulation in accordance with claim 1 wherein said copolymer has an average molecular weight of from about 500 g/mol to about 3 Mg/mol.

13. The formulation in accordance with claim 1 wherein said formulation is substantially free from added emulsifiers, surfactants and other wetters or dispersants.

14. The formulation in accordance with claim 1 wherein said formulation is substantially free from talc.

15. The formulation in accordance with claim 1 wherein the agricultural active component comprises a pesticidal ingredient.

16. The formulation in accordance with claim 15 wherein the pesticidal ingredient is selected from the group consisting of an insecticide, a fungicide and combinations thereof.

17. The formulation in accordance with claim 1 wherein the wax is selected from the group consisting of natural wax, vegetable wax, mineral wax and synthetic wax.

18. The formulation in accordance with claim 17 wherein the wax comprises polyethylene wax.

19. The formulation in accordance with claim 1 wherein the amount of the agricultural active component is from about 40% to about 60% by weight of the total formulation;
the amount of the latex carrier is from about 5 to about 10% by weight of the total formulation;
the amount of the wax is from about 5 to about 10% by weight of the total formulation; and
the amount of the mica is from about 3 to about 4% by weight of the total formulation.

20. The formulation in accordance with claim 1 wherein said binder formulation further comprises at least one stabilizing ingredient.

21. The formulation in accordance with claim 20 wherein said at least one stabilizing ingredient is selected from the group consisting of a colorant, an antifoam ingredient, a thickener, an antifreeze ingredient, a preservative and combinations thereof.

22. A seed treated with a formulation in accordance with claim 1.

23. The seed in accordance with claim 22 wherein the seed is of a plant selected from the group consisting of corn, wheat, barley, oat, rye, spelt, soybeans, rape, rice, sugar beet, cotton, sorghum, sunflowers, beans, peas, canola, rape, cabbages, tomatoes, eggplants, peppers, other vegetables and spices, ornamental shrubs and flowers.

24. The seed in accordance with claim 22 wherein the seed has a coating thereon comprising a styrene-acrylate based copolymer, a wax, mica and an agricultural active component.

25. A method for protecting a seed from pests comprising applying to a viable seed an effective amount of a formulation in accordance with claim 1.
26. The method in accordance with claim 25, comprising:
applying a seed treatment formulation in accordance with claim 1 onto a seed; and
allowing the formulation applied to the seed to dry to form a coated seed.

27. An aqueous seed treatment formulation consisting essentially of:
from about 10% to about 60% of an agricultural active component by weight;
from about 25% to about 45% of a binder formulation by weight, said binder formulation comprising:
from about 5% to about 50% of a latex carrier by weight;
from about 2% to about 40% of a wax by weight;
from about 2% to about 25% of mica by weight;
from about 0 to about 1% of an antifoam ingredient by weight;
from about 0 to about 30% of a thickener by weight;
from about 0 to about 20% of an antifreeze ingredient by weight;
from about 0 to about 1% of a preservative by weight; and
from about 0 to about 5% of a suspending aid by weight;
from about 0 to about 3% of a colorant by weight;
wherein said latex carrier comprises a styrene-acrylate based copolymer.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 13/38876

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01N 25/00; A01N 25/02 (2013.01 )
USPC - 504/100; 504/101

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) Classifications: A01N 25/00; A01N 25/02 (2013.01 )
USPC Classifications: 504/100; 504/101

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)


C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tbody>
<tr>
<td>Y</td>
<td>US 2012/0065060 A1 (REUS, HA et al.) 15 March 2012; abstract; paragraphs [0011]-[0015], [0023]-[0024], [0027]-[0028], [0030]-[0032], [0034], [0037], [0040]-[0041], [0043], [0045],[0046], [0049], claim 14</td>
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<tr>
<td>Y</td>
<td>WO 2007/103076 A1 (MOTE, JS et al.) 13 September 2007; page 4, line 28 to page 5, line 5; claim 16</td>
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<td>Y</td>
<td>US 2008/0143447 A1 (ARTHUR, KS et al.) 04 June 2009; abstract; paragraphs [0009], [0020], [0054], [0080], [0082], [-0099], [0102]-[0103]</td>
<td>12, 19</td>
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<td>Y</td>
<td>US 2010/027897 A1 (GOTTSCHLE, R et al.) 28 October 2010; paragraphs [0013]-[0014], [0020]-[0023], [0035]</td>
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</tbody>
</table>

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special significance (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Z" document member of the same patent family

Date of the actual completion of the international search: 18 September 2013 (18.09.2013)
Date of mailing of the international search report: 27 SEP 2013

Authorized officer: Shane Thomas
PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Form PCT/ISA/2 10 (second sheet) (July 2009)