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LUBRICANT COMPOSITIONS FROM BORON
NITRIDE**(75) Inventor: **William W. Garmier**, Hartville,
OH (US)Correspondence Address:
Emerson, Thomson & Bennett, LLC
777 W. Market Street
Akron, OH 44303 (US)(73) Assignee: **RENEWABLE LUBRICANTS,
INC.**(21) Appl. No.: **11/412,164**(22) Filed: **Apr. 26, 2006****Related U.S. Application Data**(60) Provisional application No. 60/675,126, filed on Apr.
26, 2005.**Publication Classification**(51) **Int. Cl.**
C10M 103/00 (2006.01)(52) **U.S. Cl.** **508/155**(57) **ABSTRACT**

This present invention discloses a method for the preparation of an improved high temperature engine lubricant composition comprising the steps of: 1) providing at least one bio-based natural oil or biobased synthetic oil selected from the group consisting of natural or synthetic vegetable oil, natural or synthetic animal oil, genetically modified vegetable oil, genetically modified synthetic vegetable oil, natural or synthetic tree oil, and mixtures thereof; 2) providing at least one boron nitride; and 3) optionally, providing at least one base oil selected from the group consisting of a synthetic ester, solvent refined petroleum oil, a hydrocracked petroleum white oil, an all hydroprocessed synthetic oil, Fischer Tropsch oil, petroleum oil group I, group II, group III, a polyalphaolefin (PAO), and mixtures thereof; 4) optionally, providing at least one additive or combination of additives selected from the group consisting of anti-oxidant(s), corrosion inhibitor(s), metal deactivator(s), viscosity modifier(s), anti-wear inhibitor(s), friction modifier(s), and extreme pressure agent(s); 5) blending 1), 2), 3), and 4) in any sequence to form said composition.

HIGH TEMPERATURE BIOBASED LUBRICANT COMPOSITIONS FROM BORON NITRIDE

[0001] This application claims priority to a provisional patent application, Ser. No. 60/675,126, filed Apr. 26, 2005, entitled HIGH TEMPERATURE BIOBASED LUBRICANT COMPOSITIONS FROM BORON NITRIDE.

FIELD OF THE INVENTION

[0002] This invention relates to biobased lubricant compositions made from natural and/or synthetic vegetable, animal, plant or tree oil and boron nitride. These compositions provide improved lubricity, anti-wear, and extreme pressure performance at extreme high temperatures up to and over 1000° C. These compositions can be particularly useful in high temperature applications for lubricating combustible engines, ovens, chains, cables, gears, hinge pins, bearings, and sliding surfaces. The lubricant composition can also be formulated into hydraulic fluids, turbine oils, compressor oils, penetrating lubricants, greases, anti-seize compounds, thread compounds, deep drawing compounds, rolling oils, metal working fluids, release agents, and any lubricant that requires antiwear and extreme pressure performance. In addition, these lubricant compositions provide high dielectric strength that is useful in electrical insulation fluids and compound.

BACKGROUND OF THE INVENTION

[0003] Biobased oils are obtainable in large volumes from renewable resources derived from vegetables, animals, plants, or trees and in general are characterized as readily biodegradable or “environmentally non-toxic”. As a result, such oils are potentially attractive for use in a wide variety of applications and are defined in the 2002 Farm Bill as biobased. These biobased oils are obtained in natural and synthetic form.

[0004] With respect to use for lubrication purposes, biobased oils have not been fully desirable. Many biobased oils do not possess the desired spectrum of characteristics relating to: pour point; oxidative stability; and compatibility with additives among others. Biobased oils do however possess many desirable properties for use as a lubricant. In particular, biobased oils typically provide high flash point, good boundary lubrication, and very high viscosity index that can provide fuel economy, and are less than 1% volatility in the NOACK test which has shown to reduce engine oil emissions. In addition, biobased oils are generally nontoxic and readily biodegradable. For example, under standard test conditions (e.g., OCED 301D and ASTM D-5864 test methods), a typical vegetable oil can biodegrade up to 80% into carbon dioxide and water in 28 days, as compared to 25% or less for typical petroleum-based lubricating fluids. The composition has exceptional benefits whenever there is direct loss of the lubricant into the environment. Sensitive areas include forestry, mining, marine, agriculture, heavy industry, transportation, rail and shipping, pulp and paper mills, saw mills, plywood mills, hoist cables and chains in marine shipping areas, draglines, drives on straddle lift lumber carriers, motorcycle and ATV chains, etc.

[0005] The biobased materials and the boron nitride in this composition are listed by the USDA and NSF as food grade

approved and are environmentally non-toxic. The equipment used in the food processing industry varies by segment with the three leading segments comprising meat and poultry, beverages, snack foods, vegetables, and dairy. While the equipment varies from segment to segment, the moving parts such as bearing, gears and slide mechanisms are similar and often require lubrication. The lubricants most often used in these applications include oven lubricants, chain lubricants, cable lubricants, penetrating lubricants, anti-seize compound, thread compound, deep drawing compound, rolling oils, mold release agents, gear oils as well as all-purpose greases. These food industry oils must meet more stringent standards than other industry lubricants.

[0006] Due to the importance of ensuring and maintaining safeguards and standards of quality for food products, the food industry must comply with the rules and regulation set forth by the United States Department of Agriculture (USDA). The Food Safety Inspection Service (FSIS) of the USDA is responsible for all programs for the inspection, grading and standardization of meat, poultry, eggs, dairy products, fruits, and vegetables. These programs are mandatory, and this inspection of non-food compounds used in federally inspected plants is required.

[0007] The FSIS is custodian of the official list of authorized compounds for use in federally inspected plants. The official list (see page 11-1, List of Proprietary Substances and Non-food Compounds, Miscellaneous Publication Number 1419 (1989) by the Food Safety and Inspection Service, United States Department of Agriculture) states that lubricants and other substances that are susceptible to incidental food contact are considered indirect food additives under USDA regulations. Therefore, these lubricants, classified as either H-1 or H-2, are required to be approved by the USDA before being used in food processing plants. The most stringent classification, H-1 is for lubricants approved for incidental food contact. The H-2 classification is for uses where there is no possibility of food contact and assures that no known poisons or carcinogens are used in the lubricant. The instant invention pertains to H-1 and H-2 approved lubricating oil. H-1 and H-2 approved oil and the terms “food grade” will be used interchangeably for the purpose of this application.

[0008] Although the USDA is no longer approving new ingredients and compositions, the H-1 and H-2 classifications are still recognized by the world food industry. NSF is now listing and approving the food grade classification.

[0009] In addition to meeting the requirements for safety set by federal regulatory agencies, the product must be an effective lubricant. Lubricating oils for food processing plants should lubricate machine parts, resist viscosity change, resist oxidation, protect against rusting and corrosion, provide wear protection, and resist the formation of deposits and sludge in service. The product should also perform effectively at various lubrications regimes ranging from hydrodynamic thick film regimes to boundary thin film regimes.

[0010] The oxidation, and thermal characteristics of a lubricating oil helps predict how effectively an oil will maintain its lubricating properties over time and resist sludge and deposit formation. Hydrocarbon oils are partially oxidized when contacted with oxygen at elevated temperatures for prolonged periods of time and can develop hard carbon deposits that cause seizer in close tolerant metal to metal contact areas.

[0011] Although such lubricants have been designed to be non-toxic as a food source contaminant their lubricating

properties are often less effective compared to conventional lubricants e.g., lubricants not having ingredients approved for direct food contact. The lubrication industry has, to some degree, overcome this problem by incorporating specialty additives into the lubricant compositions. For example, the inclusion of performance additives have been used to enhance antiwear properties, oxidation inhibition, rust/corrosion inhibition, metal passivation, extreme pressure, friction modification, foam inhibition, and lubricity. Such chemistries are described in the following patents: U.S. Pat. No. 5,538,6545 (Lawate, et al.); U.S. Pat. No. 4,062,785 (Nibert); U.S. Pat. No. 4,828,727 (McAninch); U.S. Pat. No. 5,338,471 and U.S. Pat. No. 5,413,7254 (Lai).

[0012] A drawback with the food-grade-lubricants described in the related art relates to oxidation resistance, limited formulating capability for viscosity breadth, and limited viscosity protection. The lubricants often have poor oxidation and rheology characteristics when subjected to prolonged heat and mechanical stress.

[0013] Therefore, there remains a need for a lubricant that exhibits excellent extreme pressure and anti-wear with substantial improvements in dielectric strength, oxidation resistance, viscosity index, viscosity breadth formulating capability, and viscosity stability when subjected to the thermal and mechanical stresses. In addition, this composition can provide a dry lubricating film when temperatures exceed the auto-ignition temperatures of the biobase oils without developing hard carbon deposits.

[0014] U.S. Pat. No. 4,783,274 (Jokinen et al., Nov. 8, 1988) is concerned with an anhydrous oily lubricant, which; is based on vegetable oils, which is substituted for mineral lubricant oils, and which, as its main component, contains triglycerides that are esters of saturated and/or unsaturated straight-chained C₁₀ to C₂₂ fatty acids and glycerol. The lubricant is characterized in that it contains at least 70 percent by weight of a triglyceride whose iodine number is at least 50 and no more than 125 and whose viscosity index is at least 190. As its basic component, instead of or along with the said triglyceride, the lubricant oil may also contain a polymer prepared by hot-polymerization out of the said triglyceride or out of a corresponding triglyceride. As additives, the lubricant oil may contain solvents, fatty acid derivatives, in particular their metal salts, organic or inorganic, natural or synthetic polymers, and customary additives for lubricants.

[0015] U.S. Pat. No. 5,538,654 (Lawate et al., Jul. 23, 1996) describes a food grade lubricant composition which is useful as hydraulic oil, gear oil, and compressor oil for equipment in the food service industry. This composition comprises (A) a major amount of a genetically modified vegetable oil and (B) a minor amount of a performance additive. In other embodiments the composition contains either (C) a phosphorus compound or (D) a non-genetically modified vegetable oil.

[0016] U.S. Pat. No. 5,580,482 (Chassan et al., Dec. 3, 1996) relates to a lubricant composition stabilized against the deleterious effects of heat and oxygen said composition comprising a triglyceride oil or an oil which is an ester wherein unsaturation is present in either the alcohol moiety or the acid moiety and an effective stabilizing amount of either an N,N-disubstituted aminomethyl-1,2,4-triazole or an N,N-disubstituted aminomethyl-benzotriazole and a higher alkyl substituted amide of dodecylene succinic acid.

[0017] U.S. Pat. No. 5,888,947 (Lambert et al., Mar. 30, 1999) relates to a composition that has three main components: a base oil, an oil source containing hydroxy fatty acids

and an oil source containing vegetable or animal waxes. The base oil used in the reference needs to consist of primarily triglycerols (triglycerides) and mono- and diglycerols (glycerides) and free fatty acids. The composition further consists of vegetable oils where the glycerols contain hydroxy fatty acids, making up 5% to 20% of the oil. A third component is waxes composing 5% to 10% of the oil additives by volume. Additional synthetic mimics or natural products derived from animal or vegetable compounds may be added up to 5% of the compositional volume.

[0018] U.S. Pat. No. 6,300,292 (Konishi et al., Oct. 9, 2001) relates to a hydraulic oil composition comprising vegetable oil with a total degree of unsaturation of 0.3 or less as base oil, and comprising at least one antioxidant selected from the group consisting of a phenol antioxidant, an amine antioxidant and a zinc dithiophosphate antioxidant in an amount of 0.01 to 5% by mass based on the total amount of the composition.

[0019] U.S. Pat. No. 6,312,623 (Oommen et al., Nov. 6, 2001) is directed to an electrical insulation fluid comprising at least 75% of a high oleic acid triglyceride composition that comprises fatty acid components of at least 75% oleic acid, less than 10% diunsaturated fatty acid component; less than 3% triunsaturated fatty acid component; and less than 8% saturated fatty acid component; and wherein said composition is further characterized by the properties of a dielectric strength of at least 35 KV/100 mil gap, a dissipation factor of less than 0.05% at 25° C., acidity of less than 0.03 mg KOH/g, electrical conductivity of less than 1 pS/m at 25° C., a flash point of at least 250° C. and a pour point of at least -15° C., and one or more additives selected from the group of an antioxidant additive, a pour point depressant additive and a copper deactivator.

SUMMARY OF THE INVENTION

[0020] One aspect of the present invention is to extend the variety and compass of additives and base oils useful for improving the properties of high temperature, environmental, and food-grade-lubricants. The applicant has now discovered that when boron nitrides are formulated into the inventive compositions, the compositions show enhanced lubricity, anti-wear, extreme pressure, and oxidation resistance in extreme high temperatures up to and above 1000° C. In addition, the present invention provides a high dielectric strength that is beneficial in insulating fluids and compounds. These compositions can be particularly useful in high temperature applications for lubricating combustible engines, ovens, chains, cables, gears, hinge pins, bearings, and sliding surfaces. The lubricant composition can also be formulated into hydraulic fluids, turbine oils, compressor oils, penetrants, greases, anti-seize compounds, thread compounds, deep drawing compounds, rolling oils, metal working fluids, release agents, and any lubricant that requires anti-wear and extreme pressure performance. Because of the chemical structure of the lubricant base oil(s) with the boron nitrides these inventive compositions burns relatively free from abrasive hard carbon deposits allowing the boron nitride white powder to remain on the surface to be lubricated. This inventive composition also helps prevent the continuous build up of hard carbon deposits that cause seizing in the contact zone of close tolerant areas, which is a known problem with petroleum hydrocarbons.

[0021] Furthermore, the inventive compositions have shown to have improved lubricity, anti-wear, and extreme

pressure performance at temperatures above 500° C. where graphite and molybdenum are known to fail.

[0022] Furthermore, the inventive compositions have shown to have environmental benefits in engine oils by improving fuel economy and reducing emissions.

[0023] Furthermore, the inventive compositions can be formulated to be food grade and have shown to have improved biodegradability making them environmentally non-toxic.

[0024] Another aspect of the present invention relates to an environmentally non-toxic and food-grade high temperature lubricant comprising: a) at least one biobased natural oil and biobased synthetic oil selected from the group consisting of natural or synthetic vegetable oil, natural or synthetic animal oil, genetically modified vegetable oil, genetically modified synthetic vegetable oil, natural or synthetic tree oil, and mixtures thereof; b) providing at least one boron nitride and c) optionally, other base oils and d) optionally, other additives wherein said composition ingredients have H-1 and H-2 approval as required by the United States Department of Agriculture. It is understood that the H-1 and H-2 designation will ultimately relate to a comparable classification in countries outside the United States in most cases.

[0025] In another aspect, the present invention discloses a method for the preparation of an environmentally non-toxic and food grade high temperature lubricant composition comprising the steps of 1) providing at least one biobased natural oil or biobased synthetic oil selected from the group consisting of natural or synthetic vegetable oil, natural or synthetic animal oil, genetically modified vegetable oil, genetically modified synthetic vegetable oil, natural or synthetic tree oil, and mixtures thereof; 2) providing at least one boron nitride; and 3) optionally, providing at least one base oil selected from the group consisting of a synthetic ester, solvent refined petroleum oil, a hydrocracked petroleum white oil, an all hydroprocessed synthetic oil, Fischer Tropsch base oil, petroleum oil group I, group II, group III, a polyalphaolefin (PAO), and mixtures thereof; 4) optionally, providing at least one additive selected from the group consisting of anti-oxidant(s), corrosion inhibitor(s), metal deactivator(s), viscosity modifier(s), anti-wear inhibitor(s), friction modifier(s), extreme pressure agent(s), and emulsifier(s); 5) blending 1), 2), 3), and 4) to form said composition.

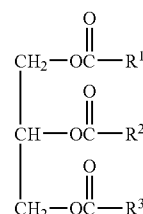
[0026] Another aspect of the invention relates to a method of enhancing the lubrication of equipment that require biodegradable fluids, engine oils that reduce environmental emissions and improve fuel economy, and equipment used in the food service industry, comprising the steps of: 1) providing at least one environmentally non-toxic and food-grade high temperature lubricant composition comprising; a) at least one biobased natural oil or biobased synthetic oil selected from the group consisting of natural or synthetic vegetable oil, natural or synthetic animal oil, genetically modified vegetable oil, genetically modified synthetic vegetable oil, natural or synthetic tree oil, and mixtures thereof; b) at least one boron nitride; and c) optionally, other base oils and; d) optionally, other additives 2) adding an effective amount of said composition into said equipment.

[0027] In accordance with another aspect of the present invention, a lubricant includes at least one biobased oil selected from the group comprising: natural or synthetic vegetable oils, natural or synthetic animal oils, genetically modified vegetable oils, genetically modified synthetic vegetable oils, natural or synthetic tree oils, and mixtures thereof and at least one boron nitride.

[0028] In accordance with another aspect of the present invention, the lubricant further comprises at least one base oil selected from the group comprising: synthetic esters, solvent refined petroleum oils, hydrocracked petroleum white oils, all hydroprocessed synthetic oils, Fischer Tropsch oils, group I petroleum oils, group II petroleum oils, group III petroleum oils, polyalphaolefins (PAOs), and mixtures thereof.

[0029] In accordance with another aspect of the present invention, the lubricant further includes at least one additive or combination of additives selected from the group comprising: anti-oxidants, corrosion inhibitors, metal deactivators, viscosity modifiers, anti-wear inhibitors, friction modifiers, and extreme pressure.

[0030] In accordance with another aspect of the present invention, the oil is a triglyceride having the formula



wherein R¹, R², and R³ are aliphatic hydrocarbyl groups that contain from about 7 to about 23 carbon atoms.

[0031] In accordance with another aspect of the present invention, the aliphatic hydrocarbyl groups are chosen from the group comprising: aliphatic hydrocarbon groups, substituted aliphatic hydrocarbon groups, and hetero groups.

[0032] In accordance with another aspect of the present invention, the triglyceride has an oleic acid profile of approximately 60% or above. In another embodiment, the oleic acid profile can be any of the following percentages: 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100.

[0033] In accordance with another aspect of the present invention, the triglyceride has a monosaturated character of approximately 60% or greater. In another embodiment, the monosaturated character can be any of the following percentages: 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100.

[0034] In accordance with another aspect of the present invention, the triglyceride has a monosaturated character of approximately 70% or greater. In another embodiment, the monosaturated character can be any of the following percentages: 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100.

[0035] In accordance with another aspect of the present invention, the triglyceride has a monosaturated character of approximately 80% or greater. In another embodiment, the monosaturated character can be any of the following percentages: 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, and 100.

[0036] In accordance with another aspect of the present invention, the oil is approximately 5% to approximately 99.9% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 50% by weight of the lubricant. In another embodiment, the oil can be any of the

following percentages: 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, and 99.

[0037] In accordance with another aspect of the present invention, the oil is approximately 65% to approximately 99.9% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 35% by weight of the lubricant. In another embodiment, the boron nitride can be any of the following percentages: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, and 35.

[0038] In accordance with another aspect of the present invention, the oil is approximately 95% to approximately 99.998% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 5% by weight of the lubricant.

[0039] In accordance with another aspect of the present invention, the biobased oil is approximately 5% to approximately 90% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 80% by weight of the lubricant, the base oil is approximately 20% to approximately 80% by weight of the lubricant, and the additive is approximately 0.001% to approximately 80% by weight of the lubricant.

[0040] In accordance with another aspect of the present invention, the biobased oil is approximately 40% to approximately 80% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 35% by weight of the lubricant, the base oil is approximately 10% to approximately 20% by weight of the lubricant, and the additive is approximately 0.001% to approximately 40% by weight of the lubricant.

[0041] In accordance with another aspect of the present invention, the biobased oil is approximately 60% to approximately 90% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 5% by weight of the lubricant, the base oil is approximately 1% to approximately 10% by weight of the lubricant, and the additive is approximately 0.001% to approximately 20% by weight of the lubricant.

[0042] In accordance with another aspect of the present invention, the oil is approximately 50% by weight, or less, of the lubricant and the boron nitride is approximately 50% by weight, or greater, of the lubricant.

[0043] In accordance with another aspect of the present invention, the biobased oil is approximately 50% by weight, or less, of the lubricant, the base oil, boron nitride, and additives together are approximately 50% by weight, or greater, of the lubricant.

[0044] In accordance with another aspect of the present invention, the biobased oil, boron nitride, and additives together are approximately 50% by weight, or less, of the lubricant, and the base oil is approximately 50% by weight, or greater, of the lubricant.

[0045] In accordance with another aspect of the present invention, a method for enhancing lubrication of equipment includes the steps of blending at least one boron nitride with at least one biobased oil selected from the group comprising: natural or synthetic vegetable oils, natural or synthetic animal oils, genetically modified vegetable oils, genetically modified synthetic vegetable oils, natural or synthetic tree oils, and

mixtures thereof and adding an effective amount of the oil and boron nitride to the equipment.

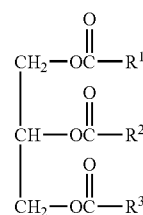
[0046] In accordance with another aspect of the present invention, the method further comprises the step of prior to adding to the equipment, blending at least one base oil selected from the group comprising: synthetic esters, solvent refined petroleum oils, hydrocracked petroleum white oils, all hydroprocessed synthetic oils, Fischer Tropsch oils, group I petroleum oils, group II petroleum oils, group III petroleum oils, polyalphaolefins (PAOs), and mixtures thereof with the biobased oil and boron nitride.

[0047] In accordance with another aspect of the present invention, the method further comprises the step of prior to adding to the equipment, blending at least one additive or combination of additives selected from the group comprising: anti-oxidants, corrosion inhibitors, metal deactivators, viscosity modifiers, anti-wear inhibitors, friction modifiers, and extreme pressure with the biobased oil, the base oil, and the boron nitride.

DETAILED DESCRIPTION OF THE INVENTION

(A) The Triglyceride Oil

[0048] In practicing this invention, the base oil is a synthetic triglyceride or a natural oil of the formula



wherein R^1 , R^2 and R^3 are aliphatic hydrocarbyl groups that contain from about 7 to about 23 carbon atoms. The term "hydrocarbyl group" as used herein denotes a radical having a carbon atom directly attached to the remainder of the molecule. The aliphatic hydrocarbyl groups include the following: (1) Aliphatic hydrocarbon groups; that is, alkyl groups such as heptyl, nonyl, undecyl, tridecyl, heptadecyl; alkenyl groups containing a single double bond such as heptenyl, nonenyl, undecenyl, tridecenyl, heptadecenyl, heneicosenyl; alkenyl groups containing 2 or 3 double bonds such as 8,11-heptadecadienyl and 8,11,14-heptadecatrienyl. All isomers of these are included, but straight chain groups are used in this embodiment. (2) Substituted aliphatic hydrocarbon groups; that is groups containing non-hydrocarbon substituents which, in the context of this invention, do not alter the predominantly hydrocarbon character of the group. Those skilled in the art will be aware of suitable substituents; examples are hydroxy, carbalkoxy, (especially lower carbalkoxy) and alkoxy (especially lower alkoxy), the term, "lower" denoting groups containing not more than 7 carbon atoms. (3) Hetero groups; that is, groups which, while having predominantly aliphatic hydrocarbon character within the context of this invention, contain atoms other than carbon present in a chain or ring otherwise composed of aliphatic carbon atoms. Suitable hetero atoms will be apparent to those skilled in the art and include, for example, oxygen, nitrogen and sulfur.

[0049] The triglyceride oils suitable for use in this invention are the vegetable and animal oils and modified vegetable and animal oils. The biobased oil triglycerides are naturally occurring oils. By “naturally occurring” it is meant that the seeds from which the oils are obtained have not been subjected to any genetic altering. Further, by “naturally occurring” it is meant that the oils obtained are not subjected to esterification hydrogenation or any chemical treatment that alters the di- and tri-unsaturation character. The naturally occurring biobased oils having utility in this invention comprise at least one of soybean oil, rapeseed oil, sunflower oil, coconut oil, lesquerella oil, canola oil, peanut oil, corn oil, cottonseed oil, palm oil, safflower oil, meadowfoam oil, animal oil, or castor oil.

[0050] The triglyceride oils may also be modified vegetable and animal oils. Triglyceride oils are modified either chemically or genetically. Hydrogenation of naturally occurring triglycerides is the primary means of chemical modification. Naturally occurring triglyceride oils have varying fatty acid profiles. The fatty acid profile for naturally occurring sunflower oil is

palmitic acid	70 percent
stearic acid	4.5 percent
oleic acid	18.7 percent
linoleic acid	67.5 percent
linolenic acid	0.8 percent
other acids	1.5 percent

[0051] By chemically modifying sunflower oil by hydrogenation, it is meant that hydrogen is permitted to react with the unsaturated fatty acid profile present such as oleic acid, linoleic acid and linolenic acid. The object is not to remove all the unsaturation. Further, the object is not to hydrogenate such that the oleic acid profile is reduced to a stearic acid profile. The object of chemical modification via hydrogenation is to engage the linoleic acid profile and reduce or convert a substantial portion of it to an oleic acid profile. The linoleic acid profile of naturally occurring sunflower oil is 67.5 percent. It is a goal of chemical modification to hydrogenate such that the linoleic acid is reduced to about 25 percent. That means that the oleic acid profile is increased from 18.7 percent to about 61 percent (18.7 percent original oleic acid profile plus 42.5 percent generated oleic acid from linoleic acid).

[0052] Hydrogenation is the reaction of a biobased oil with hydrogen gas in the presence of a catalyst. The most commonly used catalyst is a nickel catalyst. This treatment results in the addition of hydrogen to the oil, thus reducing the linoleic acid profile and linolenic acid profile. Only the unsaturated fatty acid profiles participate in the hydrogenation reaction. During hydrogenation, other reactions also occur, such as shifting of the double bonds to a new position and also twisting from the cis form to the higher melting trans form.

[0053] Table I shows the oleic acid (18:1), linoleic acid (18:2) and linolenic acid (18:3) profiles of selected naturally occurring vegetable oils. It is possible to chemically modify, via hydrogenation, a substantial portion of the linoleic acid profile of the triglyceride to increase the oleic acid profile to above 60 percent.

TABLE I

Oil	18:1	18:2	18:3
Corn oil	25.4	59.6	1.2
Cottonseed oil	18.6	54.4	0.7
Peanut oil	46.7	32.0	—
Safflower oil	12.0	77.7	0.4
Soybean oil	23.2	53.7	7.6
Sunflower oil	18.7	67.5	0.8

[0054] Genetic modification occurs in the seed stock through natural field hybridization or in a controlled laboratory under more direct genetic modification. The harvested crop then contains a triglyceride oil that when extracted has a much higher oleic acid profile and a much lower linoleic acid profile. Referring to Table I above, a naturally occurring sunflower oil has an oleic acid profile of 18.7 percent. A genetically modified sunflower oil has an oleic acid profile of 81.3 percent and linoleic acid profile of 9.0 percent. One can also genetically modify the various vegetable oils from Table I to obtain an oleic acid profile of above 90 percent. The chemically modified vegetable oils comprise at least one of a chemically modified corn oil, chemically modified cottonseed oil, chemically modified peanut oil, chemically modified palm oil, chemically modified coconut oil, chemically modified castor oil, chemically modified canola oil, chemically modified rapeseed oil, chemically modified safflower oil, chemically modified soybean oil, chemically modified animal oil, and chemically modified sunflower oil.

[0055] In one embodiment, the aliphatic hydrocarbyl groups of R^1 , R^2 , and R^3 are such that the triglyceride has a monounsaturated character of at least 60 percent, in another embodiment, at least 70 percent, and in another embodiment, at least 80 percent. Triglycerides having utility in this invention are exemplified by vegetable oils that are genetically modified such that they contain a higher than normal oleic acid content. Normal sunflower oil has an oleic acid content of 25-30 percent. By genetically modifying the seeds of sunflowers, a sunflower oil can be obtained wherein the oleic content is from about 60 percent up to about 90 percent. That is, the R^1 , R^2 , and R^3 groups are heptadecenyl groups and the R^1COO- , R^2COO- and R^3COO- to the 1,2,3-propanetriyl group CH_2CHCH_2 are the residue of an oleic acid molecule. U.S. Pat. No. 4,627,192 and U.S. Pat. No. 4,743,402 are herein incorporated by reference for their disclosure of the preparation of high oleic sunflower oil.

[0056] For example, a triglyceride comprised exclusively of an oleic acid moiety has an oleic acid content of 100% and consequently a monounsaturated content of 100%. Where the triglyceride is made up of acid moieties that are 70% oleic acid, 10% stearic acid, 13% palmitic acid, and 7% linoleic acid, the monounsaturated content is 70%. In one embodiment, the triglyceride oils are high oleic acid, that is, genetically modified vegetable oils (at least 60 percent) triglyceride oils. Typical high oleic vegetable oils employed within the instant invention are high oleic safflower oil, high oleic canola oil, high oleic peanut oil, high oleic corn oil, high oleic rapeseed oil, high oleic sunflower oil, high oleic cottonseed, high oleic lesquerella oil, high oleic palm oil, high oleic castor oil, high oleic meadowfoam oil and high oleic soybean oil. Canola oil is a variety of rapeseed oil containing less than 1 percent erucic acid. One high oleic vegetable oil is high oleic sunflower oil obtained from *Helianthus* sp. This product is available from AC Humko, Cordova, Tenn., 38018 as

TriSun™ high oleic sunflower oil. TriSun 80 is a high oleic triglyceride wherein the acid moieties comprise 80 percent oleic acid. Another high oleic vegetable oil is high oleic canola oil obtained from *Brassica campestris* or *Brassica napus*, also available from AC Humko as RS high oleic oil. RS80 oil signifies a canola oil wherein the acid moieties comprise 80 percent oleic acid.

[0057] It is further to be noted that genetically modified vegetable oils have high oleic acid contents at the expense of the di- and tri-unsaturated acids. A normal sunflower oil has from 20-40 percent oleic acid moieties and from 50-70 percent linoleic acid moieties. This gives a 90 percent content of mono- and di-unsaturated acid moieties (20+70) or (40+50). Genetically modifying vegetable oils generate a low di- or tri-unsaturated moiety vegetable oil. The genetically modified oils of this invention have an oleic acid moiety:linoleic acid moiety ratio of from about 2 up to about 90. A 60 percent oleic acid moiety content and 30 percent linoleic acid moiety content of a triglyceride oil gives a ratio of 2. A triglyceride oil made up of an 80 percent oleic acid moiety and 10 percent linoleic acid moiety gives a ratio of 8. A triglyceride oil made up of a 90 percent oleic acid moiety and 1 percent linoleic acid moiety gives a ratio of 90. The ratio for normal sunflower oil is 0.5 (30 percent oleic acid moiety and 60 percent linoleic acid moiety).

[0058] It is further to be noted that a triglyceride can be processed into a biobased synthetic ester and any of the above natural, chemically modified, and genetically modified, vegetable oils, tree oils, plant oils, and animal oils can be made into synthetic esters through an esterification process described further in this patent. Synthetic esters include polyesters, diesters, complex esters, and simple esters including methyl and ethyl esters. Additional patents that describe esterification include U.S. Pat. Nos. 6,051,539; 6,018,063; 5,885,946; 5,427,704; 5,338,471; 6,018,063; 5,994,278; 5,773,391; 6,583,302B 1; 6,774,091; and US 2003/0069146.

(B) Boron Nitrides

[0059] Advanced Ceramics Corporation is the world's largest producer of boron nitride powders, shapes and coatings, as well as other specialty ceramics.

[0060] Boron nitride powder is a soft, white lubricious (slippery) powder with unique characteristics that make it an attractive, performance-enhancing alternative to graphite, molybdenum disulfide and other frequently used inorganic solid lubricants. With its superior adherence and thermochemical stability, boron nitride presents an opportunity for applications where conventional solid lubricants break down or fail to deliver the desired performance.

[0061] This inorganic solid powder retains its ability to lubricate in extreme cold or heat and is well suited to extreme pressure (EP) applications. It is environmentally friendly and inert to most chemicals. It displays excellent electrical insulating properties and maintains those properties in vacuum, unlike graphite.

[0062] Current lubrication applications include solid polymer composite shapes, dispersed additives in petroleum solvents, oils and greases, metal-ceramic electrode-position coatings, aqueous and oil dispersions used as release agents, and constituents of epoxy coatings, thermal spray coatings and plasma spray coatings.

[0063] Boron nitride is a highly refractory (heat-resistant, stable) material with physical and chemical properties comparable to graphite. But, unlike graphite, it does not occur naturally in nature. It is typically synthesized from boric

oxide or boric acid in the presence of urea or urea derivatives and ammonia, at temperatures ranging from 800° C. to 2000° C.

[0064] The two common crystalline structures of BN are cubic and hexagonal. Cubic boron nitride, (c)BN, is like diamond, being hard and abrasive; and hexagonal boron nitride, (h)BN, is like graphite, being soft and lubricious.

[0065] The following discusses the key material properties of (h)BN that make it an ideal solid lubricant for high performance applications.

[0066] Hexagonal boron nitride powder exhibits the same characteristics of solid lubricants found in graphite and molybdenum disulfide. These include crystalline structure, low shear strength, adherence of the solid lubricant film, low abrasivity, and thermochemical stability. In many instances, (h)BN exceeds the performance levels of these conventional solid lubricant characteristics, particularly adherence and thermochemical stability.

[0067] Until recently, methods for measuring the coefficient of friction or "slip" characteristics of powders were vague at best. For example, the INSTRON method commonly used for determining coefficient of friction, is unable to discern the difference between various grades of (h)BN powder, although the differences are clearly perceptible by feel. To compare the "slip" of (h)BN to other solid lubricants, a new test apparatus was developed in conjunction with Falex Corporation.

[0068] The results of this test, seen in FIG. 1, clearly show that (h)BN yielded the lowest coefficient of friction versus all the other materials tested by this method.

[0069] To compare the extreme pressure (EP) characteristics of (h)BN to graphite, molybdenum disulfide and other lubricants, Falex 4-Ball EP tests were conducted on Fomblin® oil samples containing 5 wt % of each material.

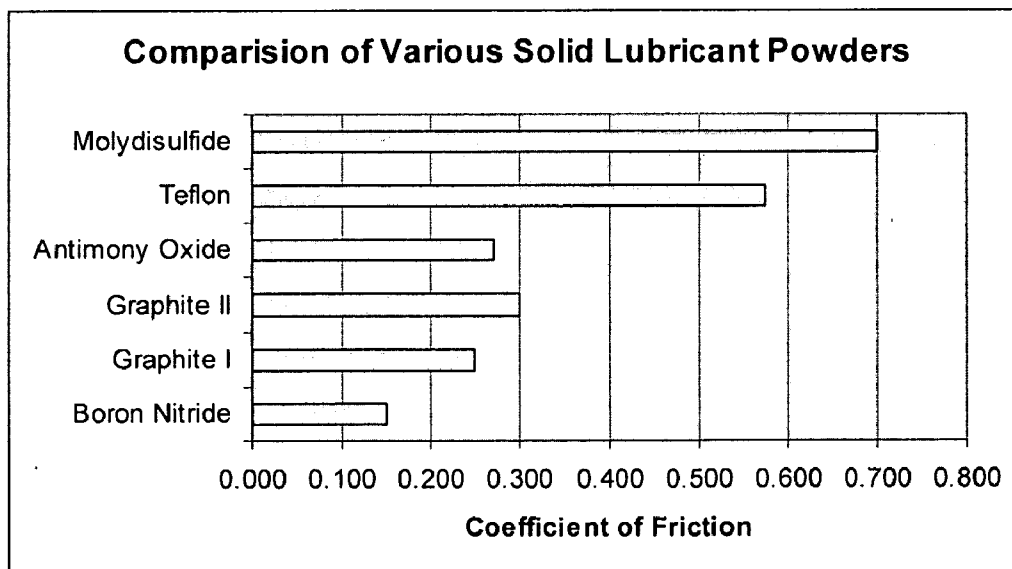
[0070] Two grades of (h)BN, two grades of graphite, molybdenum disulfide (MoS₂), antimony oxide (SbO₂) and Teflon (PTFE) were tested. Table 2 shows the results of these tests. Both the (h)BN samples showed higher weld points than any of the others. (The weld point is the amount of applied weight-kilograms of force [kgf]—that causes the lubricant to break down, allowing welding or metal-to-metal transfer.) Scar data (s pattern of metal removal prior to reaching the weld point) shows that, at baseline loading, one grade of (h)BN has slightly higher values than other solid lubricants; but at 400 kgf, both grades of (h)BN compare favorably to the group. (Baseline loading is defined as the weld point of the pure test fluid that—for this figure—was 315 kgf.)

[0071] Advanced Ceramics produces several grades of boron nitrides for lubricants. The New Boron Nitride Powder NX Grades are listed for lubricants and include NX1, NX5, NX9, and NX10. In one embodiment, the grade for filtration and solubility is NX1 which has a particle size of 1 micron or smaller.

TABLE 2

Sample	Weld Point (kgf)	Average Scar @ 315 kgf	Diameter (mm) @ 400 kgf
Fomblin ® (F), control	315.000	WELD	
F/5% BN (Grade E)	620.000	0.902	1.024
F/5% BN (Grade B)	620.000	0.850	0.984
F/5% MoS ₂	500.000	0.861	1.001
F/5% SbO ₂	400.000	0.082	WELD
F/5% Graphite (S4742)	400.000	0.839	WELD
F/5% Graphite (GP603)	400.000	0.851	WELD
F/5% Teflon	500.000	no data	1.110

Figure 1

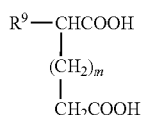


(C) The Other Oils

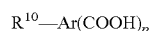
[0072] The (A) and (B) composition of this invention may further comprise other additives and oils comprising (C) (1) a synthetic ester base oil, (C) (2) a polyalphaolefin or (C) (3) unrefined, refined or rerefined oils, (C) (4) a synthetic all hydroprocessed oil and Fischer Tropsch base oils, as well as mixtures of two or more of any of (C) (1), (C) (2), (C) (3), and (C) (4). The synthetic ester base oil (C) (1) comprises the reaction of a monocarboxylic acid of the formula



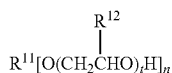
a dicarboxylic acid of the formula



or an aryl carboxylic acid of the formula



wherein R^8 is a hydrocarbyl group containing from about 4 to about 24 carbon atoms, R^9 is hydrogen or a hydrocarbyl group containing from about 4 to about 50 carbon atoms, R^{10} is hydrogen or a hydrocarbyl group containing from 1 up to about 24 carbon atoms, m is an integer of from zero to about 6 and p is an integer of from 1 to about 4; with an alcohol of the formula



wherein R^{11} is an aliphatic group containing from 1 to about 24 carbon atoms or an aromatic group containing from 6 to about 18 carbon atoms, R^{12} is hydrogen or an alkyl group containing 1 or 2 carbon atoms, t is from 0 to about 40 and n is from 1 to about 6.

[0073] Within the monocarboxylic acid, R^8 , in this embodiment, contains from about 6 to about 18 carbon atoms. An illustrative but non-exhaustive list of monocarboxylic acids are the carboxylic acids of butanoic acid, hexanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, palmitic acid, stearic acid and oleic acid, as well as isomers of these acids and mixtures thereof.

[0074] Within the dicarboxylic acid, R^9 , in this embodiment, contains from about 4 to about 24 carbon atoms and m is an integer of from 1 to about 3. An illustrative, but non-exhaustive, list of dicarboxylic acids are succinic, glutaric, adipic, pimelic, suberic, azelaic, sebacic, maleic, and fumaric acids.

[0075] As aryl carboxylic acids, R^{10} , in this embodiment, contains from about 6 to about 18 carbon atoms and p is 2. Aryl carboxylic acids having utility are benzoic, toluic, ethylbenzoic, phthalic, isophthalic, terephthalic, hemimellitic, trimellitic, trimeric, and pyromellitic acids.

[0076] Within the alcohols, R^{11} , in this embodiment, contains from about 3 to about 18 carbon atoms and t is from 0 to about 20. The alcohols may be monohydric, polyhydric or alkoxyated monohydric and polyhydric. Monohydric alcohols can comprise, for example, primary and secondary alcohols.

In one embodiment, the monohydric alcohols, however, are primary aliphatic alcohols, especially aliphatic hydrocarbon alcohols such as alkenols and alkanols. Examples of the monohydric alcohols from which R^{11} is derived include 1-octanol, 1-decanol, 1-dodecanol, 1-tetradecanol, 1-hexadecanol, 1-octadecanol, oleyl alcohol, linoleyl alcohol, linolenyl alcohol, phytol, myristyl alcohol lauryl alcohol, myristyl alcohol, cetyl alcohol, stearyl alcohol, and behenyl alcohol.

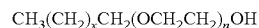
[0077] Examples of polyhydric alcohols are those containing from 2 to about 6 hydroxy groups. They are illustrated, for example, by the alkylene glycols such as ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, tripropylene glycol, dibutylene glycol, tributylene glycol, and other alkylene glycols. One class of alcohols suitable for use in this invention are those polyhydric alcohols containing up to about 12 carbon atoms. This class of alcohols includes glycerol, erythritol, pentaerythritol, dipentaerythritol, gluconic acid, glyceraldehyde, glucose, arabinose, 1,7-heptanediol, 2,4-heptanediol, 1,2,3-hexanetriol, 1,2,4-hexanetriol, 1,2,5-hexanetriol, 2,3,4-hexanetriol, 1,2,3-butanetriol, 1,2,4-butanetriol, quinic acid, 2,2,6,6-tetrakis(hydroxymethyl) cyclohexanol, 1-10-decanediol, digitalol, and the like.

[0078] Another class of polyhydric alcohols for use in this invention are the polyhydric alcohols containing 3 to 10 carbon atoms and particularly those containing 3 to 6 carbon atoms and having at least three hydroxyl groups. Such alcohols are exemplified by a glycerol, erythritol, pentaerythritol, mannitol, sorbitol, 2-hydroxymethyl-2-methyl-1,3-propanediol (trimethylolpropane), bis-trimethylolpropane, 1,2,4-hexanetriol and the like.

[0079] The alkoxyated alcohols may be alkoxyated monohydric alcohols or alkoxyated polyhydric alcohols. The alkoxy alcohols are generally produced by treating an alcohol with an excess of an alkylene oxide such as ethylene oxide or propylene oxide. For example, from about 6 to about 40 moles of ethylene oxide or propylene oxide may be condensed with an aliphatic alcohol.

[0080] In one embodiment, the aliphatic alcohol contains from about 14 to about 24 carbon atoms and may be derived from long chain fatty alcohols such as stearyl alcohol or oleyl alcohol.

[0081] The alkoxy alcohols useful in the reaction with the carboxylic acids to prepare synthetic esters are available commercially under such trade names as TRITON®, TERGITOL® from Union Carbide, ALFONIC® from Vista Chemical, and NEODOL® from Shell Chemical Company. The TRITON® materials are identified generally as polyethoxyated alkyl phenols which may be derived from straight chain or branched chain alkyl phenols. The TERGITOLS® are identified as polyethylene glycol ethers of primary or secondary alcohols; the ALFONIC® materials are identified as ethoxyated linear alcohols which may be represented by the general structure formula



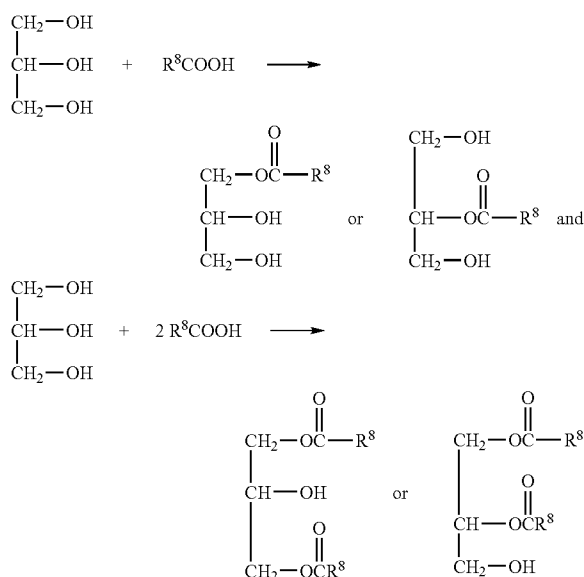
wherein x varies between 4 and 16 and n is a number between about 3 and 11. Specific examples of ALFONIC® ethoxyates characterized by the above formula include ALFONIC® 1012-60 wherein x is about 8 to 10 and n is an average of about 5.7; ALFONIC® 1214-70 wherein x is about 10-12 and n is an average of about 10.6; ALFONIC® 1412-60 wherein x is

from 10-12 and n is an average of about 7; and ALFONIC® 1218-70 wherein x is about 10-16 and n is an average of about 10.7.

[0082] The NEODOL® ethoxylates are ethoxylated alcohols wherein the alcohols are a mixture of linear and branched alcohols containing from 9 to about 15 carbon atoms. The ethoxylates are obtained by reacting the alcohols with an excess of ethylene oxide such as from about 3 to about 12 or more moles of ethylene oxide per mole of alcohol. For example, NEODOL® ethoxylate 23-6.5 is a mixed linear and branched chain alcoholate of 12 to 13 carbon atoms with an average of about 6.5 ethoxy units.

[0083] As stated above, the synthetic ester base oil comprises reacting any above-identified acid or mixtures thereof with any above-identified alcohol or mixtures thereof at a ratio of not more than 1 COOH per 1 OH group using esterification procedures, conditions and catalysts known in the art.

[0084] In some instances, not all the OH groups are reacted with the COOH groups. Examples of these synthetic ester base oils are glycerol mono-oleate and glycerol di-oleate whose reactions respectively, appear below.



[0085] When glycerol mono-oleate and glycerol di-oleate are used as (C) (1), it is common for a mixture of isomers of glycerol mono-oleate to be present and also for a mixture of isomers of glycerol di-oleate to be present.

[0086] Additional information on biobased synthetic esters and esterification procedures was included in a recently published paper presented to the United Soybean Board by Dr. Herman Benecke, a researcher at the Battelle Memorial Institute in Columbus, Ohio, titled “Recent Developments in Soybean Oil-Based Biolubricants.” Dr. Benecke reported the work conducted by Renewable Lubricants, Inc. that was contracted by Battelle to evaluate and determine methods of application to use Battelle inventive biobased synthetic esters.

[0087] A non-exhaustive list of companies that produce synthetic esters and their trade names are BASF as Glissol-

fluid, Ciba-Geigy as Reolube, JCI as Emkarote, Oleofina as Radialube and the Emery Group of Henkel Corporation as Emery.

[0088] The polyalphaolefins (C) (2) such as alkylene oxide polymers and interpolymers and derivative thereof where the terminal hydroxyl groups have been modified by esterification, etherification, etc., constitute another class of oils that can be used. These are exemplified by the oils prepared through polymerization of ethylene oxide or propylene oxide, the alkyl and aryl ethers of these polyoxyalkylene polymers (e.g., methylpolyisopropylene glycolether having an average molecule weight of about 1000, diphenyl ether of polyethylene glycol having a molecular weight of about 500-1000, diethyl ether of polypropylene glycol having a molecular weight of about 1000-1500, etc.) or mono- and polycarboxylic esters thereof, for example, the acetic acid esters, mixed C₃-C₈ fatty acid esters, or the C₁₃ Oxo acid diester of tetraethyleneglycol.

[0089] The unrefined, refined and rerefined oils, (C) (3), as well as mixtures of two or more of any of these can be used in the lubricant composition of the present invention. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment. For example, a shale oil obtained directly from retorting operations, a petroleum oil obtained directly from distillation or ester oil obtained directly from an esterification process and used without further treatment would be an unrefined oil. Within the context of this invention, mineral oils are under the purview of petroleum oils. Refined oils are similar to the unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Many such purification techniques, such as distillation, solvent extraction, acid or base extraction, filtration and percolation are known to those skilled in the art. Rerefined oils are obtained by processes similar to those used to obtain refined oils applied to refined oils which have been already used in service. Such rerefined oils are also known as reclaimed or reprocessed oils and often are additionally processed by techniques for removal of spent additives and oil breakdown products.

[0090] The all-hydroprocessed base oils (C) (4) are considered and marketed by the lubricant industry as synthetic base oils. Recent refining processes have formed a new class of synthetic oils. For example, a technical paper by the Chevron Products Company entitled: “The Synthetic Nature Of Group III Base Oils”, Presented at the 1999 Lubricants & Waxes Meeting, November 11-12, Houston Tex. (National Petrochemical & Refiners Association) discloses an all-hydroprocessing manufacturing route that combines three catalytic processes to significantly and selectively change the size, shape, and heteroatom content of the molecules to improve their lubricating properties. Hydrogen is added at high temperature and pressure in all three steps to make oil of exceptional stability. Impurities such as sulfur and nitrogen are essentially completely removed. In Group III manufacturing, feedstock is converted to saturates, which are enriched in isoparaffins. Reactive species, such as those containing aromatics, sulfur, and nitrogen are virtually gone and species that create problems with low temperature performance, such as normal paraffins, are also eliminated. Finally, the paper concludes the analysis of the feed and product from a commercial Group III production run, which shows that a vast majority of feed molecules are synthetically altered by the three catalytic processes used to make modern all-hydroprocessed Group III

base oils. These results support the claim that modern Group III base oils, made utilizing an all-hydroprocessing route, are essentially man-made or synthetic and have advantages over old technology hydrocracked base oils. In addition, their high performance in lubricant applications allows them to be used in high performance products often formulated with traditional synthetics such as polyalphaolefin (PAO). The reference did not teach the use of all-hydroprocessed group III base oils as a raw material for the preparation of biodegradable vegetable oil based lubricants.

[0091] Patents that generally disclose lubricants that can be formed using vegetable oil and group III oils include U.S. Pat. No. 6,103,673; U.S. Pat. No. 6,251,840; U.S. Pat. No. 6,451,745; and U.S. Pat. No. 6,528,458 all of which are from the Lubrizol Corporation (Wickliffe, Ohio). Additional patents include U.S. Pat. No. 6,303,547 and U.S. Pat. No. 6,444,622 both from the Ethyl Corporation (Richmond, Va.).

[0092] U.S. Pat. No. 6,528,458 discloses that compositions comprising (a) an oil of lubricating viscosity; (b) 2,5-dimercapto-1,3,4-thiadiazole (DMTD), a derivative of DMTD, or mixtures thereof; (c) a friction modifier; and (d) a dispersant, are useful for lubricating a transmission having a plurality of wet clutches and a plurality of partial power transmission shafts, wherein shifting of gears occurs by a process comprising synchronization of an engaged and a non-engaged partial transmission shaft and engagement of a wet clutch.

[0093] U.S. Pat. No. 6,451,745 discloses that a continuously variable transmission can be lubricated by supplying to them a composition of (a) an oil of lubricating viscosity; (b) a dispersant; and (c) a detergent. At least one of the dispersant (b) and the detergent (c) is a borated species, and the amount of boron present in the composition is sufficient to impart improved friction and anti-seizure properties to the composition when employed in said transmission.

[0094] U.S. Pat. No. 6,444,622 discloses mixtures of the reaction product of at least one C_5 - C_{60} carboxylic acid and at least one amine selected from the group comprising: guanidine, aminoguanidine, urea, thiourea and salts thereof and a phosphorus-containing dispersant are useful as gear oil additives.

[0095] U.S. Pat. No. 6,303,547 discloses that the reaction product of at least one C_5 - C_{60} carboxylic acid and at least one amine selected from the group comprising: guanidine, aminoguanidine, urea, thiourea, and salts thereof is useful as a gear oil additive.

[0096] U.S. Pat. No. 6,251,840 discloses a lubricating/functional fluid composition which exhibits in use improved antiwear and antifoaming properties. The improvements result from use of 2,5-dimercapto-1,3,4-thiadiazole and derivatives thereof together with silicone and/or fluorosilicone antifoam agents.

[0097] U.S. Pat. No. 6,103,673 discloses a composition comprising of an oil of lubricating viscosity; a shear stable viscosity modifier; at least 0.1 percent by weight of an over-based metal salt; at least 0.1 percent by weight of at least one phosphorus compound; and 0.1 to 0.25 percent by weight of a combination of at least two friction modifiers provides an improved fluid for continuously variable transmissions. At least one of the friction modifiers is selected from the group comprising: zinc salts of fatty acids having at least 10 carbon atoms, hydrocarbyl imidazolines containing at least 12 carbon atoms in the hydrocarbyl group, and borated epoxides. The total amount of the friction modifiers is limited to those

amounts which provide a metal-to-metal coefficient of friction of at least about 0.120 as measured at 110° C. by ASTM G-77.

[0098] The references do not disclose enabling lubricant formulations containing a combination of vegetable oil and hydroprocessed base oils (group III) and thus fail to teach or suggest the advantages associated with such formulations. Because all-hydroprocessed Group III stocks are manufactured with no solvent refining steps, when it comes to purity, they far surpass Group II or III base oils made in "hybrid" plants that maintain some solvent processing. In fact, they contain the lowest levels of impurities currently available in mineral-based oils, which, in turn gives them a significant performance advantage.

[0099] All-hydroprocessing includes three steps as follows: hydrocracking, hydroisomerization, and hydrofinishing. In the first step, hydrocracking, the majority of sulfur, nitrogen, and essentially all other non-hydrocarbon impurities are removed and most aromatics are saturated via hydrogen addition. Molecular reshaping of remaining saturated species occurs as rings are opened and paraffin isomers are redistributed, driven by thermodynamics with reaction rates facilitated by catalysts. Clean fuels are by-products of this and subsequent steps of the process. In the second step, hydroisomerization, n-paraffins and other molecules with waxy side chains are isomerized into branched molecules with much lower pour points. The majority of remaining aromatics are saturated and the majority of remaining sulfur and nitrogen species are removed. In the final step, hydrofinishing, any remaining non-isoparaffin impurities (sulfur species, nitrogen species, aromatics, and olefins) are removed to trace levels.

[0100] It is known that the all-hydroprocessed synthetics are grouped into the old Group III base oils but because of the synthetic process they can be improved upon and structured (chemically and physically) to out perform the Group III range.

[0101] Another paper, "Base Oil Supply/Demand And Quality Issues" by Dave Kramer, Chevron Texaco Global Lubricants, Presented at the 8th Annual Fuels & Lubes Asia Conference and Exhibition at the Shangri-La Hotel, Singapore from Jan. 29 through Feb. 1, 2002 discusses another process stating that "By 2007 Fischer Tropsch base oils (FTBOs) should emerge as the next quantum leap in base oil quality. These oils should have higher VIs than PAOs and outperform PAOs and existing Group IIIs in most respects. Because Fischer Tropsch projects are driven by environmental and crude oil production incentives, the volumes of FTBOs produced may greatly exceed the demand for Group III and PAOs. Kline & Company estimates that FTBO supply will swell to 10MM MT, or about 30% of the entire base oil market by 2015."

[0102] These oils in (C) are discussed further in this patent's references and the following patents: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091.

(D) Other Additives

[0103] Anti-oxidant(s) useful in this inventions including, but not limited to, are butyrate hydroxytoluene (BHT), phenyl-a-naphthylamine (PANA), and further information on anti-oxidants are listed and explained in the following patents: U.S. Pat. Nos. 5,536,493, 5,863,872, 5,990,055, 6,534,454 B1, 6,774,091.

[0104] Corrosion Inhibitor(s), Dispersant Inhibitor(s) including, but not limited to, those previously listed and also the following: surface-active organic acids, oxyacids, hydroxy acids, keto acids, borated amine, paraffin wax, imadazoline derivative, alkenyl succinic acid half ester, organic polycarboxylic acid, paraffin wax, nonyl phenoxy acetic acid, phenates, phenolic and amine antioxidants, n-oleyl sarcosine, phosphorus, carboxylic acid derivatives, zincnaphthenates, Ca sulphonate(s), Ba sulphonate(s), Ca dialkylbenzene sulphonate(s), Mg sulfonate(s), calcium dialkylbenzene sulphonate, sodium oxidate, calcium oxidate, barium oxidate, fatty acid amines, sulfurized fatty acids, amine nitrite salts, calcium nitrite, calcium acetate, calcium dichromate, calcium hypophosphite, disodium sebacate, sodium sulfonate(s), sodium mercaptobenzothiazole, sodium nitrite, sodium hydroxides, sodium salts of succinic acid/sulfonic acid, barium nitrite, barium bromate, monoethanolamine borate, dimercapto, thiediaepoles, phosphate amines, potassium salts, potassium hydroxides, phosphate esters, amine salts of carboxylic acids, monocarboxylic acids, dicarboxylic acids, tall oil imidazoline, oleyl imidazoline, vegetable waxes, alkyl zinc dithiophosphates, succinimides, esters, or Mannich dispersant, etc. and further information on corrosion inhibitors and dispersant inhibitors are listed and explained in the following patent: U.S. Pat. Nos. 5,536,493, 5,863,872, 5,990,055, 6,534,454 B1, 6,774,091.

[0105] Metal Deactivator(s) including, but not limited to, tolutriazole, tolytriazole, triazole, benzotriazole, benzothiazole, benzoimidazole, and their derivatives. These metal deactivators and others are discussed further in this patent's references and the following patents: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,774,091.

[0106] Viscosity modifier(s), Pour Point Depressants including, but not limited to, alone or in combination with, ethylene vinyl acetate copolymer, polyisobutylenes, polybutenes, polymethacrylates, olefin copolymers, esters of styrene maleic anhydride copolymers, hydrogenated styrene-diene copolymers, styrene isoprene compounds, alkylated polystyrene, hydrogenated radial polyisoprene, polyacrylate acid esters, fumed silicas, food grade tackifiers like natural rubber, etc. These viscosity modifiers and pour point depressants and others are discussed further in this patent's references and the following patents: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091.

[0107] Anti-wear inhibitor(s), friction modifier(s), extreme pressure additive(s) are, but not limited to, alone or in combination with, as follows: synthetic ester, sulfurized synthetic esters, synthetic ester polymers, phosphorous sulfurs, fatty phosphites, phosphites, phosphate esters, borate ester, boron oxide, calcium sulfonates, sodium sulfonates, polysulfides, sulfurized fats, sulfurized olefin, sulfurized vegetable oils, antimony, zinc (ZDP), copper, polytetrafluoroethylene, molybdenum, and graphite compounds. Some of these additives serve as multifunctional additives including antioxidants, for example zinc dithiophosphate is a multi-function additive in that it functions as a corrosion inhibitor, antiwear agent, and antioxidants added to organic materials to retard oxidation. These additives and others are discussed further in this patent's references and the following patents: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091.

[0108] Emulsifier(s) including, but not limited to, anionic and non-ionic can also be added to the invention to improve water emulsification or solubility of the formulas.

[0109] The invention also contemplates the use of an effective amount of other additives in the lubricating and functional fluid compositions of this invention. Such additives include, for example, detergents and dispersants of the ash-producing or ashless type, corrosion and oxidation-inhibiting agents, pour point depressing agents, auxiliary extreme pressure and/or antiwear agents, color stabilizers and anti-foam agents.

[0110] Complete additive packages which incorporate a dispersant inhibitor with a conventional detergent and/or a corrosion inhibitor could be purchased off the shelf with or in substitution of the dispersion inhibitor. Lubrizol's LZ8955 and/or LZ9802 or combinations thereof with each other and/or other dispersion inhibitors may be used. The newest additive packages produced by Lubrizol include the Core API SL LZ 20001, Anti Oxidant booster LZ 8676, and Friction Modifier booster LZ 8650 for ILSAC GF3/GF4.

[0111] These additives and others are discussed further in Lubrizol's Data and MSDS Sheets, this patent's references, and the following patents: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091.

[0112] The compositions of the present invention comprising components (A) and (B) or (A), (B), and (C), or (A), (B), (C), and (D) are useful as high temperature biodegradable lubricants, food grade lubricants, and engine oils.

[0113] When the composition comprises components (A) and (B), the following states the ranges of these components in parts by weight.

Component	First Embodiment	Second Embodiment	Third Embodiment
(A)	5-99.9	65-99.9	95-99.998
(B)	0.002-50	0.002-35	0.002-5

[0114] When the composition comprises components (A), (B), (C) and (D), the following states the ranges of these components in parts by weight.

Component	First Embodiment	Second Embodiment	Third Embodiment
(A)	5-90	40-80	60-90
(B)	0.002-80	0.002-35	0.002-5
(C)	20-80	10-20	1-10
(D)	0.001-80	0.001-40	0.001-20

[0115] It is also to be recognized that concentrates of the invention can be formed. The concentrates comprise a minor amount of (A) with a major amount of (B), a minor amount of (A) and a major amount of the combination of (B), (C), and (D) or a minor amount of the combination of (A), (C), and (D) with a major amount of (B).

[0116] The term "minor amount" as used in the description and appended claims is intended to mean that when a composition contains a "minor amount" of a specific material that amount is less than 50 percent by weight of the composition.

[0117] The term "major amount" as used in the description and appended claims is intended to mean that when a composition contains a "major amount" of a specific material that amount is more than 50 percent by weight of the composition.

[0118] It is understood that other components besides (A), (B), (C), and (D) may be present within the composition of this invention.

[0119] The components of this invention are blended together according to the above ranges to effect solution. Order of addition is of no consequence, although typically (B), (C), and (D) are added to (A).

[0120] Below are some formulated examples:

[0121] NP 343 is a polyol ester from ExxonMobil that has been identified as biobased by the USDA, Indopol H 1500 is a food grade polybutene from British Petroleum (BP), PD23 is a white food grade mineral oil from Witco Corporation, and Boron Nitrides are food grade.

Component	Viscosity	% weight
<u>Formula #883 Bio High Temperature (HT) Oven Chain and Cable Lubricant</u>		
NP343	19.30	73.00
NX5 Boron Nitride	Powder	3.00
Indopol H 1500	50,000.00	24.00
Specific gravity @ 15.6° C.	0.952	
Viscosity, cSt @40° C.	174.16	
<u>Formula #883A Bio HT Lubricant ISO 100 for multifunctional applications</u>		
NP343	19.30	80.00
NX5 Boron Nitride	Powder	3.00
Indopol H 1500	50,000.00	17.00
Viscosity, cSt @40° C.	96.35	
<u>Formula #883B Bio HT Oven Chain Lubricant USDA H-2</u>		
NP343	19.30	73.00
NX5 Boron Nitride	Powder	3.00
Indopol H 1500	50,000.00	19.00
PD 23	2.40	5.00
Viscosity, cSt @40° C.	97.19	
<u>Formula #883C Bio HT Grease Base Oil</u>		
NP343	19.30	79.50
NX1 Boron Nitride	Powder	2.50
Indopol H 1500	50,000.00	18.00
Viscosity, cSt @40° C.	131.64	
<u>Formula #883D Bio HT Oven Chain Lubricant USDA H-1</u>		
High Oleic Canola	38.71	82.50
NX1 Boron Nitride	1.10	2.50
Indopol H 1500	50,000.00	15.00
Viscosity, cSt @40° C.	156.92	

[0122] Another aspect of the invention relates to a method of enhancing the lubrication of an engine by improving oxidation, stability, reducing emission volatility, and reducing friction that improves fuel economy. Reference patents that teach high temperature oxidation stability, reducing deposits and volatility, and friction reduction include the following: U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091.

[0123] These patents also teach the utilization of a synergy of two or more antioxidants and/or antiwear extreme pressure agents and the benefits of combining these components to reduce oxidation and greatly lower the coefficient of friction.

[0124] Most of the informative reference patents are owned by the applicant and/or Renewable Lubricants, Inc. with the exception of U.S. Pat. No. 6,774,091, which is owned by Ashland Inc. (Valvoline).

[0125] The applicant has now found that boron nitride can be used in combination with molybdenum compounds and/or polytetrafluoroethylene to replace one of the additives.

[0126] This present invention discloses a method for the preparation of an improved high temperature engine lubricant composition comprising the steps of: 1) providing at least one biobased natural oil or biobased synthetic oil selected from the group consisting of natural or synthetic vegetable oil, natural or synthetic animal oil, genetically modified vegetable oil, genetically modified synthetic vegetable oil, natural or synthetic tree oil, and mixtures thereof; 2) providing at least one boron nitride; and 3) optionally, providing at least one base oil selected from the group consisting of a synthetic ester, solvent refined petroleum oil, a hydrocracked petroleum white oil, an all hydroprocessed synthetic oil, Fischer Tropsch oil, petroleum oil group I, group II, group III, a polyalphaolefin (PAO), and mixtures thereof; 4) optionally, providing at least one additive or combination of additives selected from the group consisting of anti-oxidant(s), corrosion inhibitor(s), metal deactivator(s), viscosity modifier(s), anti-wear inhibitor(s), friction modifier(s), and extreme pressure agent(s) selected in patents U.S. Pat. Nos. 5,990,055, 5,863,872, 5,736,493, 6,534,454 B1, 6,774,091, 6,620,772, 6,624,124, 6,383,992 and provisional patents filed by Renewable Lubricants, Inc. to include 60/474,572 and 60/502,669; 5) blending 1), 2), 3), and 4) in any sequence to form said composition.

[0127] It is theorized that the combination of chemical constituents comprising the instant invention result in a reduction of friction between moving parts of the engine so that in operation an extremely fine film of the chemical constituents is formed on the metal surfaces.

[0128] At the high temperature and high pressure within the engine, the surface active ingredients react with the film continuously forming an extremely thin lubricating layer thereon having an extremely low coefficient of friction and wear even under extreme temperature and pressure providing superior lubrication during the start-up and running phase of the engine.

[0129] Below are some formulated examples that have been formulated to 10.5-10.7 cSt. (SAE 30) with the 5W meeting the cold temperature pumpability for the Mini Rotor Viscometer at -35° C.:

Component	Viscosity	% weight
<u>Passenger Car Motor Oil (PCMO) Synthetic SAE 5W30</u>		
Group III	4.10	67.35
LZ7070D	1150.00	9.20
LZ20001	210.00	9.15
NP343	4.30	13.00
LZ6662	500.00	1.00
LZ8676	8.00	0.50
LZ8650	8.00	0.50
Molyvan 855	55.00	0.15
NX1 Boron Nitride	Powder	0.15
<u>Passenger Car Motor Oil Synthetic SAE 5W30</u>		
PAO4	4.10	9.85
PAO6	5.80	61.20

-continued

Component	Viscosity	% weight
LZ7070D	1150.00	6.50
LZ20001	210.00	9.15
LZ8676	8.00	0.50
LZ8650	8.00	0.50
NP343	4.30	13.00
Molyvan 855	55.00	0.15
NX1 Boron Nitride	Powder	0.15
Passenger Car Motor Oil Synthetic SAE 5W30		
Group III	4.10	66.70
LZ7070D	1150.00	9.20
LZ20001	210.00	9.15
NP343	4.30	13.00
LZ6662	500.00	1.00
LZ8676	8.00	0.50
LZ8650	8.00	0.50
Molyvan 855	55.00	0.10
NX1 Boron Nitride	Powder	0.10
Teflon	8.00	0.10
Passenger Car Motor Oil Synthetic SAE 5W30		
PAO4	4.10	11.20
PAO6	5.80	61.20
LZ7070D	1150.00	6.50
LZ20001	210.00	9.15
LZ8676	8.00	0.50
LZ8650	8.00	0.50
NP343	4.30	13.00
Molyvan 855	55.00	0.10
NX1 Boron Nitride	Powder	0.10
Teflon	8.00	0.10
Passenger Car Motor Oil Synthetic SAE 5W30		
Group III	4.10	67.50
LZ7070D	1150.00	9.20
LZ20001	210.00	9.15
LZ8676	8.00	0.50
LZ8650	8.00	0.50
NP343	4.30	13.00
LZ6662	500.00	1.00
NX1 Boron Nitride	Powder	0.15
Passenger Car Motor Oil Synthetic SAE 5W30		
PAO4	4.10	10.00
PAO6	5.80	61.20
LZ7070D	1150.00	6.50
LZ20001	210.00	9.15
LZ8676	8.00	0.50
LZ8650	8.00	0.50
NP343	4.30	13.00
NX1 Boron Nitride	Powder	0.15

[0130] The boron nitride particle additives sometimes disperse better when formulated into the base oil carrier and/or biobased oil prior to formulating. An example would be, but does not limit to, 1 part boron nitride dispersed in 3-10 parts NP343.

Passenger Car Motor Oil Concentrated Additive Formula as a Biobased Booster Package (Bio-Booster Pak) to Top Treat Conventional Motor Oils		
Component	Viscosity	% weight
NP343	4.30	66.85
LZ8676	8.00	59.00
LZ7070D	1150.00	9.00
LZ20001	210.00	9.15
LZ6662	500.00	1.00

-continued

Passenger Car Motor Oil Concentrated Additive Formula as a Biobased Booster Package (Bio-Booster Pak) to Top Treat Conventional Motor Oils		
Component	Viscosity	% weight
LZ8650	8.00	3.00
Molyvan 855	55.00	2.00
NX1 Boron Nitride	Powder	2.00
Teflon	8.00	2.00

[0131] This concentrated additive is formulated where an 8 ounce bottle will treat 4-5 quarts of motor oil. Bio-Booster Pak can be added to gasoline engines to extend the oil life and increase the life of the engines by reducing wear and improving fuel economy. The package has a higher percentage of extreme pressure friction modifiers and antiwear (LZ8650 identified by Lubrizol as a friction modifier supplement for crank case engine oils) and antioxidant (LZ8676 identified by Lubrizol as an antioxidant supplement for crank case engine oils to meet the new API SL/SM and ILSAC GF3/GF4). The concentrated balance of these additives does not exceed the treat rates when added as a concentrate to the motor oils. The engine additive package LZ20001, the pour point depressant LZ6662, and the viscosity modifier LZ7070D are added at the proper percentages to help balance and not dilute the additives already in the fully formulated engine oils. The Molyvan 855, NX1 Boron Nitride, and Teflon have also been increased to match the percentages in the above formulas when fully formulated. Bio-Booster Pak has been formulated to the viscosity of 12 cSt. so when adding the additive at approximately 5% (8 ounces to 5 quarts) to an SAE 20, SAE 30, SAE 40, or SAE 50 viscosity it will not take the formulation out of the SAE engine oil viscosity specification.

[0132] The Bio-Booster Pak can be formulated in the same method as described above to meet heavy duty diesel motor (HDMO) specifications by replacing LZ20001 with LZ4998 diesel engine additive package with booster additives LZ8790, LZ8791, and LZ8791Z that are commercially available and identified from the Lubrizol Corporation. The Bio-Booster Pak can also be varied in viscosity, for example older vehicles will receive benefits by boosting the standard factory fill 10.5 cSt. oil to the high side of the SAE grade of 12 cSt. This can be done by increasing the polymer or adding a heavier viscosity biobased oil. The polymer can also be improved by adding a more shear stable polymer as in LZ7075F replacing LZ7070D. A proper procedure would be to formulate a booster pack for HDMO as well as one for PCMO.

Modifications

[0133] Specific compositions, methods, or embodiments discussed are intended to be only illustrative of the invention disclosed by this specification. Variation on these compositions, methods, or embodiments are readily apparent to the person of skill in the art based upon the teachings of this specification and are therefore intended to be included as part of the inventions disclosed herein.

[0134] The foregoing detailed description is given primarily for clearness of understanding and no unnecessary limitations are to be understood therefrom, for modification will become obvious to those skilled in the art upon reading this disclosure and may be made upon departing from the spirit of

the invention and scope of the appended claims. Accordingly, this invention is not intended to be limited by the specific exemplifications presented hereinabove. Rather, what is intended to be covered is within the spirit and scope of the appended claims.

[0135] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements.

[0136] The invention has been described with reference to several embodiments. Obviously, modifications and alterations will occur to others upon a reading and understanding of the specification. It is intended by applicant to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

Having thus described the invention, it is now claimed:

1. A liquid lubricant comprising:

at least one biobased oil selected from the group comprising: natural or synthetic vegetable oils, natural or synthetic animal oils, genetically modified vegetable oils, genetically modified synthetic vegetable oils, natural or synthetic tree oils, and mixtures thereof; and,

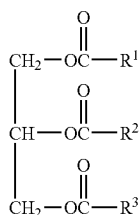
at least one boron nitride, wherein the boron nitride is in suspension in the biobased oil.

2. The lubricant of claim 1, wherein the lubricant further comprises at least one base oil selected from the group comprising: synthetic esters, solvent refined petroleum oils, hydrocracked petroleum white oils, all hydroprocessed synthetic oils, Fischer Tropsch oils, group I petroleum oils, group II petroleum oils, group III petroleum oils, polyalphaolefins (PAOs), and mixtures thereof, wherein the base oil, the biobased oil, and the boron nitride are food grade.

3. The lubricant of claim 2, wherein the lubricant further comprises:

at least one additive or combination of additives selected from the group comprising: anti-oxidants, corrosion inhibitors, metal deactivators, viscosity modifiers, anti-wear inhibitors, friction modifiers, and extreme pressure, wherein the base oil, the biobased oil, the boron nitride, and the additive are all H-1 approved food grade.

4. The lubricant of claim 1, wherein the oil is a triglyceride having the formula



wherein R^1 , R^2 , and R^3 are aliphatic hydrocarbyl groups that contain from 7 to 23 carbon atoms, wherein the lubricant does not include a thickener.

5. The lubricant of claim 4, wherein the aliphatic hydrocarbyl groups are chosen from the group comprising: aliphatic hydrocarbon groups, substituted aliphatic hydrocarbon groups, and hetero groups.

6. The lubricant of claim 5, wherein the triglyceride has an oleic acid profile of approximately 60% or above.

7. The lubricant of claim 4, wherein the triglyceride has a monounsaturated character of approximately 60% or greater.

8. The lubricant of claim 7, wherein the triglyceride has a monounsaturated character of approximately 70% or greater.

9. The lubricant of claim 8, wherein the triglyceride has a monounsaturated character of approximately 80% or greater.

10. The lubricant of claim 1, wherein the oil is approximately 5% to approximately 99.9% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 50% by weight of the lubricant, wherein the lubricant maintains stability at temperatures above 500° C.

11. The lubricant of claim 10, wherein the oil is approximately 65% to approximately 99.9% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 35% by weight of the lubricant.

12. The lubricant of claim 11, wherein the oil is approximately 95% to approximately 99.998% by weight of the lubricant and the boron nitride is approximately 0.002% to approximately 5% by weight of the lubricant.

13. The lubricant of claim 3, wherein the biobased oil is approximately 5% to approximately 90% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 80% by weight of the lubricant, the base oil is approximately 20% to approximately 80% by weight of the lubricant, and the additive is approximately 0.001% to approximately 80% by weight of the lubricant, wherein the lubricant maintains stability at temperatures above 500° C.

14. The lubricant of claim 13, wherein the biobased oil is approximately 40% to approximately 80% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 35% by weight of the lubricant, the base oil is approximately 10% to approximately 20% by weight of the lubricant, and the additive is approximately 0.001% to approximately 40% by weight of the lubricant.

15. The lubricant of claim 14, wherein the biobased oil is approximately 60% to approximately 90% by weight of the lubricant, the boron nitride is approximately 0.002% to approximately 5% by weight of the lubricant, the base oil is approximately 1% to approximately 10% by weight of the lubricant, and the additive is approximately 0.001% to approximately 20% by weight of the lubricant.

16. The lubricant of claim 1, wherein the oil is approximately 50% by weight, or less, of the lubricant and the boron nitride is approximately 50% by weight, or greater, of the lubricant, wherein the lubricant maintains stability at temperatures above 500° C.

17. The lubricant of claim 3, wherein the biobased oil is approximately 50% by weight, or less, of the lubricant, the base oil, boron nitride, and additives together are approximately 50% by weight, or greater, of the lubricant, wherein the lubricant maintains stability at temperatures above 500° C.

18. The lubricant of claim 3, wherein the biobased oil, boron nitride, and additives together are approximately 50% by weight, or less, of the lubricant, and the base oil is approximately 50% by weight, or greater, of the lubricant, wherein the lubricant maintains stability at temperatures above 500° C.

19. A method for enhancing lubrication of equipment, the method comprising the steps of:

blending at least one food grade boron nitride with at least one liquid food grade biobased oil selected from the

group comprising: natural or synthetic vegetable oils, natural or synthetic animal oils, genetically modified vegetable oils, genetically modified synthetic vegetable oils, natural or synthetic tree oils, and mixtures thereof, wherein the boron nitride is in suspension in the oil; and, adding an effective amount of the oil and boron nitride to the equipment.

20. The method of claim **19**, wherein the method further comprises the step of:

prior to adding to the equipment, blending at least one base oil selected from the group comprising: synthetic esters, solvent refined petroleum oils, hydrocracked petroleum white oils, all hydroprocessed synthetic oils, Fischer Tropsch oils, group I petroleum oils, group II petroleum oils, group III petroleum oils, polyalphaolefins (PAOs), and mixtures thereof with the biobased oil and boron nitride, wherein the composition contains substantially no thickeners.

21. The method of claim **20**, wherein the method further comprises the step of:

prior to adding to the equipment, blending at least one additive or combination of additives selected from the group comprising: anti-oxidants, corrosion inhibitors, metal deactivators, viscosity modifiers, anti-wear inhibitors, friction modifiers, and extreme pressure with the biobased oil, the base oil, and the boron nitride.

22. The method of claim **20**, wherein the method further comprises the step of:

providing a dry lubricating film of the boron nitride when temperatures exceed the auto-ignition temperature of

the biobased oil, wherein the equipment is high temperature equipment, wherein operation temperatures exceed 500° C.

23. The method of claim **22**, wherein the film is created without developing hard carbon deposits.

24. The composition of claim **1**, wherein the composition creates a dry lubricating film of the boron nitride when temperatures exceed the auto-ignition temperature of the biobased oil.

25. The composition of claim **24**, wherein the film is created without developing hard carbon deposits.

26. The composition of claim **1**, wherein the biobased oil is sunflower oil, and the boron nitride is hexagonal boron nitride powder, wherein the boron nitride is in an amount greater than 2% by weight.

27. The lubricant of claim **1**, wherein the lubricant is substantially free of sulfur.

28. The lubricant of claim **1**, wherein the boron nitride is approximately 11% to approximately 80% by weight.

29. The lubricant of claim **28**, wherein the boron nitride is approximately 35% to approximately 80% by weight.

30. The lubricant of claim **1**, wherein the boron nitride is approximately 0.002% by weight.

31. The lubricant of claim **27**, wherein the lubricant further comprises at least one base oil selected from the group comprising: all hydroprocessed synthetic oils, Fischer Tropsch oils, and mixtures thereof.

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