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(54) **NANOPARTICULATE BASED LUBRICANTS**

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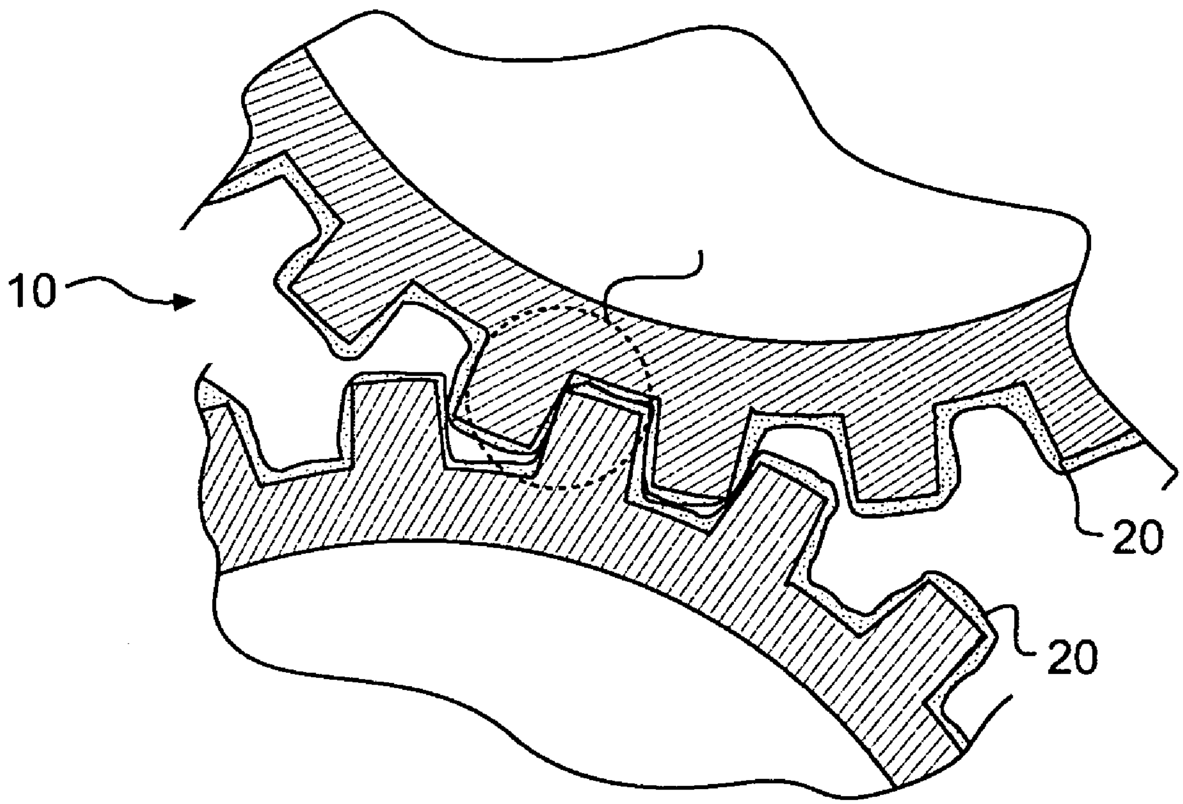
(57) **ABSTRACT**

A method of making a nanoparticulate based lubricant is disclosed. The method includes providing solid lubricant material with particles having a size less than or equal to about 500 nanometers, and treating the particles to create composite nanoparticles. The composite nanoparticles includes the solid lubricant material and at least a second material.



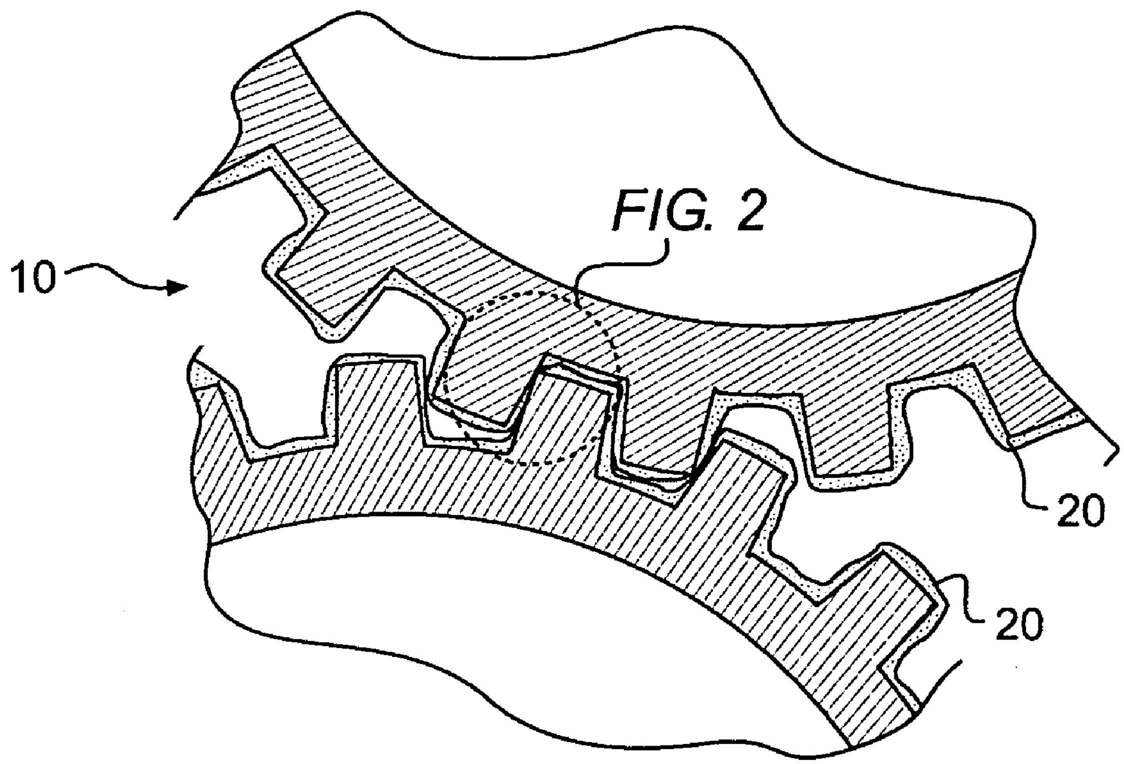


FIG. 1

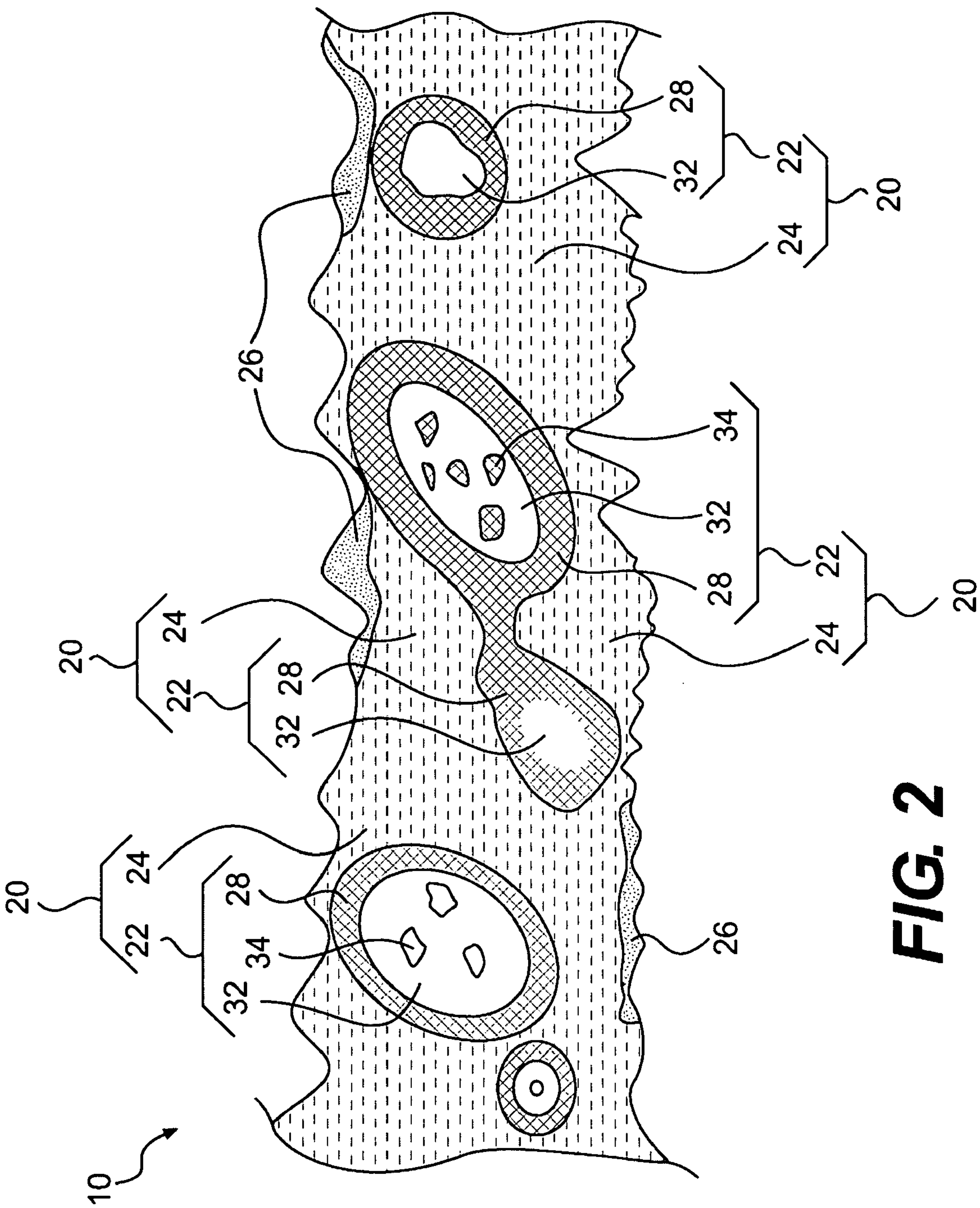


FIG. 2

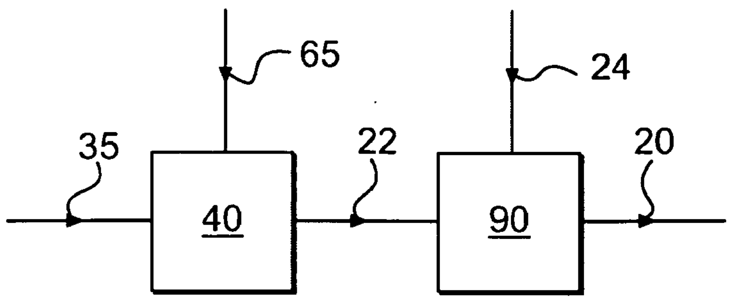


FIG. 3

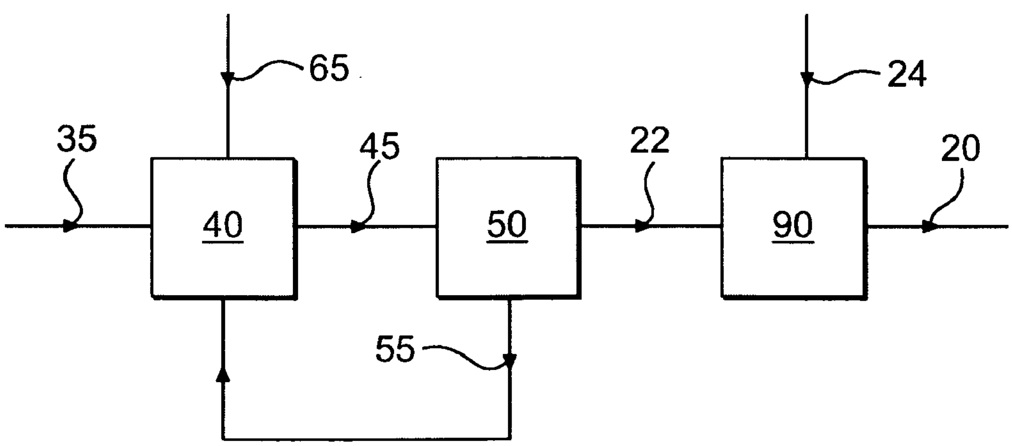


FIG. 4

NANOPARTICULATE BASED LUBRICANTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from U.S. Provisional Application No. 60/880,025 to Malshe et al. filed on Jan. 12, 2007, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates generally to lubricants and, more particularly, to lubricants containing nanoparticles of a solid lubricant.

BACKGROUND

[0003] Lubricants are introduced between contacting (sliding or rolling) surfaces of dynamic systems to reduce the friction and wear therebetween. Lubrication occurs when these moving surfaces are separated by a lubricant film and an applied load is carried by the lubricant. In general, four regimes of lubrication are broadly defined based upon the mechanism by which the lubricant operates to reduce friction between the moving parts. These four regimes are: hydrodynamic lubrication, mixed lubrication, boundary lubrication, and enhanced pressure lubrication. In the hydrodynamic and mixed lubrication regimes, the film of lubricant (a thick film in the case of hydrodynamic and a thin film in the case of mixed lubrication) separates the moving surfaces. In boundary layer and enhanced pressure regimes, lubrication is provided by a thin solid layer of the lubricant formed on the surface of the moving parts. This thin solid lubricant layer is formed by material sheared off from solid lubricant particles or reaction products of additives contained within the lubricant.

[0004] Nanoparticulate based lubricants utilize specially designed nanometer sized solid particles to produce chemically and physically stable solid lubricant layers at the contact zone of dynamic systems. Under conditions of load and temperature produced by the contacting surfaces, these nanoparticles undergo structural deformation resulting in the formation of the thin solid lubricant layer on the contacting surfaces, capable of shear/sliding motion. In addition to the thin solid layer providing lubrication by allowing for shear deformation, the nanoparticles also reduce friction between the surfaces by acting as tiny balls in a bearing between the contacting surfaces. The lubricating effect is enhanced by novel properties of the nanoparticles that arise from their curvature and size, as these particles approach molecular dimensions (less than or equal to 500 nanometers). In contrast with solid lubricant particles of larger dimensions, the small size of the nanoparticles allows its permeation deep into the micro and meso asperities of the contacting surfaces to provide lubrication.

[0005] One application of a nanoparticle based lubricant is described in U.S. Pat. No. 6,710,020 (hereinafter the '020 patent) issued to Tenne et al. on Mar. 23, 2004. The '020 patent discloses hollow fullerene-like nanoparticles of diameters between 10 nanometers and 200 nanometers, used as solid lubricants between contacting surfaces. In the '020 patent, a composite structure comprising a porous matrix made of a metal, alloy or a semiconductor (base metal) and inorganic fullerene-like (IF) nanoparticles of a metal chalcogenide are provided as the lubricant ensemble. The IF nanoparticles are impregnated within the pores of the base metal, which serve as a reservoir for the IF nanoparticles, which are slowly released to the surface of the base metal to provide lubrication. In the '020 patent, the IF nanoparticles are synthesized in a reactor. For example, in one embodiment, tungsten disulphide (WS_2) IF nanoparticles are prepared by reacting hydrogen sulphide (H_2S) and hydrogen gas (H_2) with tungsten oxide (WO_3) nanoparticles in a fluidized bed reactor at 850° C. During the reaction process, a closed WS_2 monolayer is formed on the surface of the WO_3 nanoparticle. As the reaction proceeds, the oxygen atoms diffuse out of the WO_3 and closed WS_2 layers replace the oxide core. After a few hours of the reaction process, WS_2 nanoparticles of diameter less than or equal to 200 nanoparticles are obtained. These nanoparticles are then subjected to different cleaning and purification steps and dispersed within an organic fluid prior to impregnation into the pores of the base metal.

[0006] Although the technique of the '020 patent may be capable of producing nanoparticles below 200 nanometers, this technique may have some limitations. For instance, the surface chemical reactivity of the particles of nanometer dimensions may be high. Therefore, the discrete nanoparticles produced by the technique of the '020 patent may have a tendency to bind together (agglomerate). Additionally, because the '020 patent relies on chemical synthesis to produce the IF nanoparticles, the quantity of the nanoparticles that may be practically produced using this technique, may be limited. Scaling the chemical synthesis process to produce a sufficient quantity of nanoparticles for bulk commercial applications, may increase the cost of such lubricants making them unviable for common applications.

[0007] The present disclosure is directed at overcoming one or more of the shortcomings of the prior nanoparticle based lubricants.

SUMMARY OF THE INVENTION

[0008] In one aspect, the present disclosure is directed toward a method of making a nanoparticulate based lubricant. The method includes providing solid lubricant material with particles having a size less or equal to about 500 nanometers, and treating the particles to create composite nanoparticles. The composite nanoparticles include the solid lubricant material and at least a second material.

[0009] In another aspect, the present disclosure is directed toward a nanoparticle for lubricant applications. The nanoparticle includes a core made substantially of a first material and having a size less than or equal to about 500 nanometers. The first material includes one or more solid lubricant materials. The nanoparticle also includes a shell on an external surface of the core, wherein the shell is substantially made of a second material.

[0010] In yet another aspect, the present disclosure is directed toward a lubricant. The lubricant includes a base oil and composite nanoparticles. The composite nanoparticles include a core made of one or more materials and a shell made of another material, wherein the shell substantially surrounds the core. The lubricant further includes lubricant additives.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** illustrates exemplary surfaces under frictional contact;

[0012] FIG. **2** illustrates an enlarged view of a region of the surfaces of FIG. **1**;

[0013] FIG. **3** illustrates an exemplary process of manufacture of the nanoparticle based lubricant of FIG. **2**; and

[0014] FIG. **4** illustrates another exemplary process of manufacture of the nanoparticle based lubricant of FIG. **2**.

DETAILED DESCRIPTION

[0015] FIG. **1** illustrate exemplary surfaces **10** under frictional contact. These surfaces **10** may be part of a machine that performs some sort of operation associated with an industry. Non limiting examples of surfaces **10** may include, contacting surfaces of a piston and a cylinder within an internal combustion engine, mating surfaces of a transmission gear assembly, etc. A lubricant **20** is disposed between the surfaces **10** under frictional contact. The lubricant **20** may be a substance introduced between the surfaces **10** to reduce the friction and wear therebetween. In some cases, this reduction in friction may be accomplished by the lubricant **20** forming a protective film on the surfaces **10**.

[0016] The lubricant **20** may, in some cases, be composed of several different materials. The lubricant **20** may include a liquid such as organic oils (for example, vegetable oils, seed oils and mineral oils), hydrocarbon base oils (for example, fossil fuel based oils), synthetic liquids (for example, hydrogenated polyolefin's, esters, silicone, and fluorocarbons), and combinations of these oils, or others. Additives may also be mixed with the lubricant **20** to enhance desirable properties, such as improved viscosity index, improved resistance to corrosion and oxidation, enhanced aging characteristics, etc. The lubricant **20** may alternatively be a mixture of a liquid and a solid lubricant. For example, the lubricant **20** may include a suspension of a solid lubricant in a liquid medium. In some cases, the lubricant **20** may be composed entirely of a solid lubricant. These solid lubricants may include dichalcogenides such as molybdenum disulphide (MoS_2), tungsten disulphide (WS_2), niobium diselinide ($NbSe_2$), soft metals such as gold (Au), silver (Ag), lead (Pb), and tin (Sn), or any other solid lubricant known in the industry.

[0017] FIG. **2** illustrates an enlarged view of a region of the surfaces **10** of FIG. **1**. The lubricant **20** between the surfaces **10** may include nanoparticles **22** of the solid lubricant. In the embodiment illustrated in FIG. **2**, the nanoparticles **22** of the solid lubricant are included within a liquid medium **24**. This liquid medium **24** may include the organic oils, the hydrocarbon based oils, the synthetic liquids, and the additives described earlier, or may include other liquid media used in lubricants known in the art. The liquid medium **24** may be used to transport the solid lubricant nanoparticles **22** to the contacting surfaces **10**. It may also be used as the lubrication medium in hydrodynamic lubrication and mixed lubrication regimes. In some cases, the liquid medium **24** may also remove heat generated by friction away from the surfaces **10**. It is also contemplated that in some cases, the liquid medium **24** may include volatile liquids that evaporate leaving behind nanoparticles **22** of the solid lubricant on the contacting surfaces **10**. In some other embodiments, the liquid medium **24** may be omitted from the lubricant **20**.

[0018] The lubricant **20** may include a plurality of nanoparticles **22** of a solid lubricant of any shape. In this application, a nanoparticle is defined as a multi-material composite particle (made of more than one material) with a size less than or equal to about 500 nanometers. Typically, the size of a nanoparticle refers to the diameter of a sphere that superscribes the nanoparticle **22**. In some embodiments, however, the nanoparticles **22** may not exist as discrete particles in the lubricant **20**, but multiple nanoparticles may be connected together. In these cases, the size of the nanoparticle refers to the size of core of the nanoparticle **22**. In some embodiments, the nanoparticles **22** may have a range of sizes less than or equal to 500 nanometers (such as, less than or equal to 400 nanometers, or less than or equal to 400 nanometers). In some embodiments, a majority of the nanoparticles **22** in the lubricant **20** will have a size less than or equal to about 500 nanometers. In some other embodiments, the average size of the nanoparticles **22** will be less than or equal to about 500 nanometers. In a preferred embodiment, the nanoparticles **22** may have a range of sizes below about 500 nanometers with a majority of particles having an average size below about 200 nanometers. While the nanoparticles **22** may possess any shape, it is contemplated that in some applications, the shape of a substantial number of nanoparticles **22** may be tailored to a specific general shape, for example, a generally platelet like or a generally spherical shape.

[0019] As mentioned earlier, the nanoparticles **22** may be composed of two or more materials. The nanoparticles **22** may include a core **32** made of one material and a shell **28** made of another material. In some cases, the core **32** may itself be made of multiple materials and the shell **28** made of a different material. The core **32** may include cavities **34** that may contain another material, for instance, the shell material. The cavities **34** in the core **32** may include intergranular spaces and/or pores within the material. In some embodiments, the material in the cavities **34** may be the product of a chemical reaction between the material of the core **32** and the material of the shell **28**. While in other embodiments, the cavities **34** may contain a material different from the core **32** and the shell **28**. It is also contemplated that in some embodiments, the core **32** may be substantially free of cavities **34**, or that any cavities **34** present may be unfilled.

[0020] The nanoparticles **22** may be made up of solid lubricants and other chemicals that enable the nanoparticle **22** to be stable at nanometer dimensions. The core **32** of the nanoparticle **22** may be made of any solid lubricant material. In this disclosure, a solid lubricant material is meant to include materials that are typically used as solid lubricants in the industry and other metals or chemicals that are capable of being reduced to nanometer dimensions. For example, the core **32** may be made of molybdenum disulphide (MoS_2), tungsten disulphide (WS_2), niobium diselinide ($NbSe_2$), metals such as gold (Au), silver (Ag), lead (Pb), tin (Sn), enhanced pressure chemicals or salts and any other solid lubricant known in the industry. In some applications, the core **32** may substantially be made of one solid lubricant material, while in other applications, the core **32** may include multiple solid lubricant materials. It contemplated that a lubricant **20** may include a mixture of different types of nanoparticles **22**. That is, the lubricant **20** may include nanoparticles **22** with the core made of substantially one material, nanoparticles **22** with the core **32** made of multiple solid lubricant materials, and nanoparticles **22** with the core **32** made of a different solid lubricant material. For example, some of the nanoparticles **22** may have MoS_2 included in the core **32** while some other nanoparticles **22** may have WS_2 included in the core **32**.

[0021] The shell **28** may include a chemical agent. The chemical agent may impart desirable properties to the lubricant **20**. This chemical agent may be phosphate based, amine based, sulphate based, or boron based. Non-limiting examples of materials that may be used as a chemical agent may include zinc dialkyl dithio phosphate (ZDDP), sodium tripolyphosphate, potassium diphosphate, 2-ethylhexyl molybdenum dithiophosphate, and combinations thereof. In some cases, more than one chemical agent may also be used. In some embodiments, the chemical agent may be made of a material that may be converted to a stable boundary film in a lubrication application. In some embodiments, the shell **28** may serve as a surface stabilization agent for the core **32**. That is, the chemical agent may react with the surface of the core **32**, and form a shell around the core **32**. This shell **28** may reduce the surface energy of the core **32**, thereby reducing the tendency of discrete nanoparticles **22** to agglomerate and grow in size. In cases where the chemical agent reacts with the core material, the shell **28** may be made as the reaction product of the chemical agent and the core material. In some other embodiments, the chemical agent may settle on the surface of the core and harden. In these embodiments, the shell **28** may be made of the material of the chemical agent. It is also contemplated that the shell **28** may be a reaction product of the chemical agent and other reactants.

[0022] The chemical agent may seep into the core **32** and may fill cavities **34** and other spaces within the core **32**. In some embodiments, the chemical agent that seeps into the core **32** may react with the core material to form a reaction product. In these embodiments, a cross-section of the nanoparticle **22** may exhibit a layered appearance with the proportion of the chemical agent (or the reaction product of the chemical agent and the core material) increasing towards the exterior of the nanoparticle **22**.

[0023] The size of the nanoparticles **22** may change over time. For instance, the size of the nanoparticles **22** may decrease over time. This decrease in size may be the result of material transfer from the nanoparticle **22** to the contacting surfaces **10** through delamination processes at the contact zone. The material delaminated from the nanoparticle **22** may form a solid lubricant layer **26** on the surfaces **10**. The solid lubricant layer **26** may start accumulating over parts of the surfaces **10** and may increase in coverage over time. In some embodiments, the accumulated solid lubricant layer **26** may cover substantial areas of the surfaces **10**, over time. The composition of the nanoparticles **22** may also change with time. The changing composition may also be due to the transfer of material from the nanoparticle **22** to the solid lubricant layer **26**. Alternatively or additionally, the chemical agent that soaked into the core **32** of the nanoparticle **22** may leak out, thereby, changing the composition of the nanoparticle **22** over time.

[0024] FIG. **3** illustrates an exemplary process of manufacture of the nanoparticle **22** based lubricant **20**. Solid lubricant material **35** may be loaded into a chemical-mechanical grinding machine **40**. The chemical-mechanical grinding machine **40** may be any means capable of grinding (reducing the physical size of) the solid lubricant material **35** to a powder and enabling a chemical reaction between a chemical agent and the solid lubricant material **35**. The chemical-mechanical grinding machine **40** may include a mechanical ball mill, rod mill, SAG mill, autogenous mill, pebble mill, high pressure grinding rolls, buhrstone mill, or any other grinding means capable of grinding solid lubricant material into a powder. A chemical agent **65** may also be fed into the chemical-mechanical grinding machine **40**. The chemical agent **65** may be a solid, liquid or a gelatinous type material. It is also contemplated that, in some application, the chemical agent **65** may be a gaseous material. In some embodiments, commercially available solid lubricant material **35** in the form of a coarse powder may partially fill a tumbler of the chemical-mechanical grinding machine **40**, along with the chemical agent **65** and a grinding medium. The grinding medium may include, for example, stainless steel or ceramic balls. The tumbler may then be rotated or agitated, causing the grinding media to grind the solid lubricant material **35** into a powder. The chemical agent **65** may further react with the powder to form nanoparticles **22** with a core **32** and a shell **28**. In some embodiments, the solid lubricant powder and the chemical agent **65** may also be subjected to one or more heating steps during grinding. It is also contemplated that the grinding and/or the reaction step may be conducted under a selected ambient condition, for example, under an inert gas, or at an elevated temperature.

[0025] In another embodiment, the chemical-mechanical grinding machine **40** may include multiple machines, and the conversion of the solid lubricant material **35** to the nanoparticles **22** may occur in multiple stages. For example, a first chemical-mechanical grinding machine may grind the solid lubricant material **35** to a powder of a predetermined size greater than about 500 nanometers under a selected ambient condition. This powder may be then be ground in the same or a second chemical-mechanical grinding machine/operation further. The second chemical-mechanical grinding machine/operation may be similar to the first chemical-mechanical grinding machine/operation, or it may be different. For instance, the first chemical-mechanical grinding machine may be a dry grinding machine and the second chemical-mechanical grinding machine may be a wet grinding machine that grinds the powder output from the first chemical-mechanical grinding machine in the presence of a liquid chemical agent **65**. Grinding the powder in the presence of the liquid chemical agent **65** may produce the nanoparticles **22**. Measurement and filtration processes may also be incorporated between the multiple grinding operations.

[0026] Any combination of grinding processes and chemical processes may be used to manufacture the nanoparticles **22**. For instance, in one embodiment, two solid lubricant materials are ground separately (in the same or different chemical-mechanical grinding machines) to form two groups of solid lubricant powders. These powders may be mixed with chemical agents (the same or different chemical agents) separately and subjected to another grinding process to form two groups of nanoparticles **22**. These groups of nanoparticles **22** may then be mixed together. In another embodiment, the two groups of solid lubricant powders, that are formed by grinding the solid lubricant materials separately, are first mixed together and then treated with a chemical agent **65**. The mixed powders are further ground in the presence of the same or a different chemical agent to form the nanoparticles **22**.

[0027] The nanoparticles **22** that are output from the chemical-mechanical grinding machine **40** may then be mixed with a liquid medium **24** in a mixing machine **90**. The mixing machine **90** may include any means capable of producing a well mixed suspension of the nanoparticles **22** in the liquid medium **24**. The mixing machine **90** may include a mechanical mixer, an ultrasonic mixer or any other mixer known in the art. In embodiments where a solid lubricant is desired, the nanoparticles **22** output from the chemical mechanical grinding machine **40** may be used as the lubricant **20**.

[0028] The liquid medium **24** may include any organic oil, a hydrocarbon based oil, or a synthetic liquid described earlier. Various additives may be also be mixed with the liquid medium **24**. These additives may enhance the desirable properties of the lubricant **20**. For example, the additives may protect the lubricated surfaces **10** from rust and/or wear, enhance the properties of the lubricant **20** for specific applications, and protect the lubricant **20** from oxidizing. These additives may include acid neutralizers, antifoam agents, antioxidants, antirust agents, corrosion inhibitors, detergents, dispersants, emulsifiers, extreme pressure additives, oiliness enhancers, pour point depressants, tackiness agents, viscosity index improvers, and/or any other lubricant additives that are known in the art. Additionally or alternatively, in some embodiments, the additives may be pre-mixed with the chemical agent **65**.

[0029] In some embodiments, the lubricant **20** containing the nanoparticles **22** may be further subjected to various measurement processes and purification processes (not shown). The measurement processes may measure various physical and/or chemical characteristics, such as viscosity, nanoparticle loading, lubricity, etc., of the lubricant **20**. In some embodiments, the suspension may be routed back to the chemical-mechanical grinding machine **40** or the mixing machine **90** for further processing based on the readings of the various measurement processes. The purification processes may involve removal of contaminants and other undesirable materials from the lubricant **20**.

[0030] FIG. **4** shows another embodiment of the process of manufacture of the nanoparticle **22** based lubricant **20**. In the embodiment shown in FIG. **4**, the solid lubricant powder **45**, output from the first grinding machine, may be passed through a filtration device **50**. The filtration device **50** may separate large particle size powder **55**, where the average particle size is greater than a desired value, from the nanoparticles **22**. The filtered large particle size powder **55** may be routed back to the chemical-mechanical grinding machine **40** for further grinding, while the nanoparticles **22** may be routed downstream for further processing. It is also contemplated that other sensing or separation devices or techniques may be used in addition to or in place of the filtration device **50** to detect the size of the solid lubricant powder **45**.

INDUSTRIAL APPLICABILITY

[0031] The disclosed nanoparticulate based lubricants **20** can be used to reduce the friction and/or wear between any moving parts. The lubricant **20** contains nanoparticles **22** that act as spacers to separate the surfaces **10** of the moving parts. The nanoparticles **22** may also reduce friction between the surfaces **10** by acting as a ball bearing between the surfaces **10**. The lubricating effect may also be enhanced by novel properties of the nanoparticles **22** that arise from their curvature and molecular dimensions. The nanoparticles **22** may have a composite structure and may possess an internal core **32** made of a solid lubricant material and an outer shell **28** made of a chemical agent that imparts desirable properties to the lubricant **20**. The chemical agent may also serve as a surface stabilization agent that reacts with the surface of the solid lubricant core **32** to form a shell **28** that reduces the tendency of the nanoparticles **22** to agglomerate and grow in size.

[0032] Under conditions of friction between the surfaces **10**, the nanoparticles **22** may undergo structural deformation, resulting in material delaminating from the nanoparticle **22** and forming a solid lubricant layer **26** on the surfaces **10** that is capable of accommodating sliding/shear motion. This phenomenon of formation of a lubricating film on the surfaces **10** may also lead to reduced friction and wear between components in the boundary and enhanced pressure lubrication regime.

[0033] The process of manufacture the nanoparticulate based lubricant **20** includes reducing the size of commercially available solid lubricant particles to nanometer dimensions by mechanical means, and surface stabilization by reacting these particles with a chemical agent. The resulting nanoparticles **22** may possess a composite structure with a solid lubricant core **32** surrounded by a shell **28** of the chemical agent. These nanoparticles **22** may be used as a solid lubricant powder, or may be dispersed in a liquid medium **24** to create a liquid lubricant.

[0034] To illustrate the process of manufacture of a nanoparticulate based lubricant **20**, an example case will be described. Commercially available MoS_2 powder, between about 700 nanometers and about 1 micron (1000 nanometers) in size, may be subjected to mechanical milling in a SPEX CertiPrep model 8000D ball milling machine. Milling may be conducted in the presence of a liquid chemical media of zinc dialkyl dithio phosphate (ZDDP) using a grinding media of hardened stainless steel grinding balls. The resulting slurry of the nanoparticles **22** in the chemical media may contain particles ranging in sizes between about 20 nanometers and 200 nanometers. Some of the nanoparticles contained in the slurry may possess a MoS_2 core and a phosphate based shell. Some of the nanoparticles **22** may also show penetration of the chemical media into the cavities **34** of the MoS_2 core. This slurry containing nanoparticles **22** can be used as a lubricant paste or can be mixed with a base oil to serve as a liquid lubricant.

[0035] In the nanoparticles **22** formed using this technique, the surface energy of the nanometer sized particles may dissipate by reaction with the chemical agent. The resulting composite structure of the nanoparticles **22** with a solid lubricant core **32** and an encapsulating shell **28** may reduce the tendency of the nanoparticles **22** to agglomerate and grow in size. The composite structure of the nanoparticles **22**, therefore, may help maintain the nanometer dimensions of the nanoparticles **22**, while retaining the novel properties arising out of the small dimensions of the nanoparticles **22**.

[0036] Since the manufacture of the nanoparticles **22** involves mechanical grinding processes that are routinely used in industry, the manufacturing technique is well suited for bulk production. Commonly available mechanical grinding machines can also be easily incorporated into conventional production lines. The capability of the technique to bulk produce the nanoparticles, and the ability to incorporate the required machinery into production lines may make the lubricants produced by this technique, cost effective.

[0037] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed nanoparticulate based lubricants **20**. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed nanoparticulate based lubricants **20**. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. A method of making a nanoparticulate based lubricant comprising;

providing solid lubricant material with particles having a size less than or equal to about 500 nanometers; and treating the particles to create composite nanoparticles, wherein the composite nanoparticles includes the solid lubricant material and at least a second material.

2. The method of claim **1**, wherein the step of providing includes reducing the size of the particles to less than or equal to 500 nanometers.

3. The method of claim **1**, wherein the step of providing includes reducing the size of the particles to a range between about 50-200 nanometers.

4. The method of claim **1**, wherein the composite nanoparticles include a central core and an outer shell wherein, the central core is substantially made of one or more materials and the outer shell is substantially made of the second material.

5. The method of claim **4**, wherein the second material includes one of a chemical and a reaction product of the chemical.

6. The method of claim **5**, wherein the chemical is selected from a group consisting of zinc dialkyl dithio phosphate (ZDDP), sodium tripolyphosphate, potassium diphosphate, 2-ethylhexyl molybdenum dithiophosphate, and combinations thereof.

7. The method of claim **4**, wherein the outer shell substantially encapsulates the central core.

8. The method of claim **4**, further including a third material disposed within cavities in the central core.

9. The method of claim **8**, wherein the third material includes one of a chemical and a reaction product of the chemical.

10. The method of claim **1**, wherein the step of treating includes chemically reacting the particles with a chemical.

11. The method of claim **1**, wherein the solid lubricant material is selected from a group consisting of molybdenum disulphide, tungsten disulphide, niobium diselinide, gold, silver, lead, tin, enhanced pressure chemicals, and combinations thereof.

12. The method of claim **1**, further including mixing the composite nanoparticles with a base oil, wherein the base oil is selected from a group consisting of an organic oil, a hydrocarbon based oil, a synthetic liquid, or combinations thereof.

13. The method of claim **12**, further including mixing the composite nanoparticles with one or more lubricant additives.

14. The method of claim **1**, wherein the step of providing includes reducing the size of the solid lubricant material to a powder having a first predetermined size greater than about 500 nanometers.

15. The method of claim **14**, wherein the step of providing further includes reducing the powder from the first predetermined size to particles having the size less than or equal to approximately 500 nanometers.

16. A nanoparticle for lubricant applications comprising;

a core made substantially of a first material and having a size less than or equal to about 500 nanometers wherein, the first material includes one or more solid lubricant materials; and

a shell on an external surface of the core, wherein the shell is substantially made of a second material.

17. The nanoparticle of claim **16**, wherein the shell substantially surrounds the core.

18. The nanoparticle of claim **16**, wherein the second material is one of a chemical agent and a reaction product of the chemical agent.

19. A lubricant comprising;

a base oil;

composite nanoparticles that include a core made of one or more materials and a shell made of another material, wherein the shell substantially surrounds the core; and

lubricant additives.

20. The lubricant of claim **19**, wherein a size of the composite nanoparticles is less than or equal to about 500 nanometers.

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