FAQs for NanoGlide®

What is NanoGlide®?

NanoGlide is a family of nanocomposite additives for lubricants such as oils and greases. Synthesized through environmentally-friendly methods, this multi-component nanoparticle additive system provides an "active" solution for boundary lubrication to significantly reduce wear and lower friction, improving efficiency and durability of machinery ranging from construction and mining equipment to truck and automobile bearings and gears, motors and generators, wind turbines, helicopters and other aircraft. NanoGlide also can be used in metal-working fluids to increase efficiency of metal-working operations.

What exactly is this additive system made of?

NanoGlide is based on a flexible architecture that allows additives to be designed (nanoengineered) using materials specifically chosen to give optimum performance in each application. The basic design consists of inorganic solid core nanoparticles integrated with organic molecules in a protective capping layer. The capping layer can include additional secondary chemistries. The core inorganic nanoparticles are made from solid lubricant materials such as molybdenum disulfide (MoS_2) hexagonal boron nitride (BN), graphite (C), or tungsten disulfide (WS_2). Additional phosphate-based, nitrogen-based, or boron-based chemical agents are included in the nanocomposite to impart the needed properties to the lubricant based on the requirements of the application.

What are the main categories of applications for NanoGlide®?

NanoGlide can be used to reduce wear and friction between pairs of moving parts in mechanical components, particularly in extreme pressure conditions involving high load and low velocity (boundary lubrication). Such components include gears, pin joints, bearings, cutting tools, and other components used in a variety of industries such as automotive, aerospace, power generation, construction and mining.

How is the NanoGlide® additive made?

NanoGlide additives are synthesized using a patent-pending process which includes chemo-mechanical milling; a top-down nanomanufacturing method. This process is capable of producing solid lubricant nanoparticles of different sizes and shapes, and modifying them with chemical agents to produce nanocomposites with the desired lubrication properties. Once produced, the nanoparticle-based additive can be blended into oils or greases to produce finished lubricants.

What is the advantage of nano-sized lubricant particles? What is "nano" anyway?

Simply put, nanotechnology is the advancement of materials science down to the scale of billionths of a meter – the scale of molecules. Materials produced at the nano scale have demonstrated many unique properties and functional capabilities that are not realized with bulk materials manufactured at a more conventional size.

So what's important about the use of nano-size solid lubricant particles? The lubricating properties of solid lubricants are realized through their "layered" crystal structure that facilitates easy shearing (layers sliding over one another). As particle layers shear off, they provide a protective film on the contact surfaces. However, in order to do this, the particles must make their way into the space between the two mating surfaces. When surfaces are under heavy load and liquid lubricants are squeezed out, the space between the surface asperities (high points) in the contact zone can be less than one micron (one millionth of a meter). As a result, conventional micron-sized particles cannot enter the zone – but nanoparticles can. Also, micron-sized particles may get trapped in filters for systems that include oil filtration. Finally, in addition to forming a protective film on the contact surfaces, nano-scale particles can offer additional protection by over-coating and trapping wear debris particles that are formed in the contact zone which might otherwise scratch or wear the surfaces.

How stable is the additive when mixed with oil?

This is an important question when dealing with solid particles dispersed in a liquid – if the particles fall out of suspension they can no longer participate in lubrication. Nanoparticles, because of their very small size, have less tendency to settle out. However, one of the major challenges with nanoparticles is that they do not like to stay "nano" – they tend to clump together (agglomerate) and form micro-sized clusters or agglomerates. This can prevent them from entering the contact zone, and it can cause them to settle out more quickly. An advantage of the NanoGlide composite particles is that the attachment of organic material to the surface of the solid lubricant particles enables them to stay apart and not agglomerate, thus increasing their stability when dispersed in oil.

Is NanoGlide® technology suitable for use in all lubrication applications?

NanoGlide® is compatible with a wide range of oils and greases. The flexibility of the NanoGlide technology allows the design of additives that can meet lubrication requirements for most engineered components with sliding or rolling contact of metal surfaces during operation. To enhance oxidation stability and/or extreme pressure properties, various phosphate-based, boron-based and nitrogen-based chemical agents can be integrated into the nanocomposite to impart application-specific properties to the lubricant. Also, the shapes of the nanoparticles can be tailored in the nanomanufacturing process to form

nanoparticles with ellipsoidal, platelet or nano-rod architectures and with different shell chemistries.

Applications where NanoGlide may not be suitable are those in which the lubricant is subject to ultra-fine particle filtration, which could remove the particles from the lubricant or clog the filters, or if there are other components whose functions may be impacted by the presence of the nanoparticles.

How does the NanoGlide® additive compare to other available solid lubricant additives like polytetrafluoroethylene (PTFE), tungsten disulfide, etc?

PTFE has been used as a solid lubricant in some applications. However, synthesis of effective PTFE lubricant particles as an additive requires incorporation of fillers or use of surface modification techniques such as ion or electron radiation to improve t dimensional stability. This makes PTFE more costly. Also, PTFE degrades more quickly as operating temperature increases, (in contrast to materials such as molybdenum disulfide or tungsten disulfide) and forms a noxious gas near 650°F. PTFE also tends to "ball-up" or congeal at high temperatures, creating the possibility of plugging oil passages or pick-up screens.

Fullerene-like nanoparticles of tungsten disulfide have been proposed for use in lubricant additives. However, they are synthesized using a lengthy process that involves high temperatures and use of volatile and non-environmentally friendly chemicals, contributing to relatively high costs and low production rates. In contrast, NanoGlide is manufactured using a simple yet novel chemo-mechanical milling process that does not involve high temperatures, uses "green" chemistries that do not produce volatile by-products during manufacture, and can be easily scaled up for high production volumes. Also, laboratory testing has shown that NanoGlide gives better performance in extreme pressure lubrication as compared to a tungsten disulfide fullerene-based additive.

What testing has been done to demonstrate the performance of NanoGlide® additives?

A wide range of tests have been performed and more are underway. Standardized tribological tests performed to examine performance in oils and greases include pin-on-disk, ball-on-disk, four-ball wear and 4-ball extreme pressure (EP) tests, block-on-ring, and ring-on-ring tests. These have been conducted in accordance with industry standards, and they have been performed not just at NanoMech, but also at our collaborators' facilities, and at independent third-party test labs. In addition to standard laboratory testing, tests that simulate specific application conditions such as gearbox lubrication have been performed and more are planned; these include Wedeven Associates' WAM tests and FZG gear rig tests. Additional component-level tests and field tests also will be performed for specific applications.

How does NanoGlide® compare cost-wise to other advanced additives?

NanoGlide offers outstanding performance as an additive for high performance systems. It's expected that greases and lubricants with the NanoGlide additive will be sold at a new price/performance tier compared to more common lubrication products on the market today, given its ability to reduce friction and wear. As each application is different--thus requiring different NanoGlide formulations—pricing of the NanoGlide additive is determined on a case-by-case basis. The method used in the manufacturing of NanoGlide is very cost-efficient compared with some other extreme pressure lubricant additives.

Is NanoGlide® suitable for gear lubrication?

Yes, definitely. NanoGlide reduces wear in gears by producing chemically and physically stable solid lubricant layers at the contact zone. The nanometric sizes of the particles allow them to penetrate into the contact zone between the mating surfaces and provide lubrication at the friction points. NanoGlide begins working almost immediately when a machine or gearbox starts up, unlike some conventional additives that are activated only after certain temperatures and pressures have been reached.

Laboratory tests, including four-ball wear and four-ball extreme pressure tests, have shown that NanoGlide added to a typical gear oil can reduce wear by more than 10% based on standard wear scar measurements, and increase load-carrying capacity by over 40%. This is critically important for machinery that must operate under heavy loads, such as construction and mining equipment, power transmissions used in heavy-duty trucks, helicopters, and other critical applications. Other advantages offered by NanoGlide in gear oils include increased operating time, reduced noise, and increased energy efficiency.

What advantages does NanoGlide® provide in metal-working fluids (MWF) or minimum quantity lubrication (MQL) applications in manufacturing?

NanoGlide offers significant advantages when incorporated into metal-working fluids, particularly for Minimum Quantity Lubrication where much smaller quantities of fluids are required. During the machining process, the nanoparticles are sacrificed to form a lubricating film on the contacting surfaces and also aid in heat transfer through evaporation of the organic molecules capped on the nanoparticles. This results in reduced cutting forces, reduced energy consumption, lower wear rates of the cutting tool, and better surface finish of the machined components.

Testing of NanoGlide in commercial metal-working fluids in an MQL grinding operation has shown a 40% reduction in tangential cutting forces and specific energy consumption, and over 30% increase in G-ratio (an indicator of the amount of material that can be removed from the workpiece during grinding, for a given amount of wear on the grinding wheel).

Does NanoGlide® perform well in greases?

Yes. Laboratory tests (four-ball wear and extreme pressure performance tests) with commercial lithium complex greases have shown that NanoGlide can reduce wear by more than 20% as compared to conventional EP additives, based on standard wear scar measurements. Coefficient of friction is reduced by up to 50%. Also, the tests demonstrate significant increase in the load-carrying capability – Load Wear Index (LWI) can be increased by more than 40% when NanoGlide is used instead of conventional EP additives. In addition, use of NanoGlide allows a reduction in the quantity of sulfur and phosphorus in the finished lubricant, making it more environmentally friendly.

How do I decide whether NanoGlide® is suitable for my specific application?

Please call our technical team a 479-756-9999 to discuss the potential for NanoGlide to add value in your particular applications.

Is NanoGlide® manufactured in-house at NanoMech?

Yes. NanoGlide samples are currently produced at our new nanomanufacturing facility in Springdale, Arkansas.

Is the NanoGlide® technology patented?

NanoGlide technology is patent-pending and all commercial rights are the exclusive property of NanoMech through a license agreement.

What are the initial and longer-term applications envisioned for NanoGlide®?

Initial formulations of NanoGlide are suitable for applications including mechanical joints such as pin joints, gearboxes, and bearings including journal bearings, ball bearings, couplers, universal joints, etc. NanoMech also is working with partners and collaborators around the world to develop additives suitable for a wide range of additional applications including engines, drills used in oil and gas exploration or production, air compressors, metal-working fluids including minimum quantity lubrication (MQL) grinding and cutting applications, and others.

When will NanoGlide® be ready for future applications such as engines?

NanoGlide formulations for engines are under development and are expected to be available soon.

What NanoGlide® additive packages are available now?

Currently, NanoMech provides samples of NanoGlide additive packages for oils and greases.

How can I get NanoGlide® samples to test? Can I get them from my current lubrication supplier?

Currently, NanoGlide samples are available directly from NanoMech for evaluation and testing in accordance with an approved test plan. Interested companies should contact us via the NanoMech web site www.nanomech.biz, by sending an email to NanoGlide@nanomech.biz, or by calling us at 479-756-9999 for more information.

In what form is NanoGlide® provided?

NanoGlide additives can be provided in the form of a concentrate to top-treat oils and greases, or as a dilution for mixing with oils. Please, contact us for assistance to determine the best form for your specific application.