Nanolubricant and Nanofluid Formulations for Tribological and Thermal management

Inventor
Mohsen Mosleh, Ph.D.

Fields
Industrial Lubricants
Cutting fluids
Coolants

Technology
Dispersion of nanoparticles with specific geometrical and morphological characteristics in lubricating oils, cutting fluids, and coolants
Below-room-temperature and at-room-temperature gelling of resultant nanofluids/nanolubricants for prolonged shelf life

Key Features
- Reduction of Wear
- Conditioning of surfaces for optimum frictional behavior
- Higher rate of heat transfer
- Reduced overall cost

Stage of Development
Proof of concept in laboratory testing and drilling process

Status
Seeking development & licensing partners.

Patent Status for all 4 pending
PCT/US12/39593), May 2012, PCT/US12/39621, 12/576,643), 2009

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Technology
This portfolio of patents at Howard University introduces several technologies related to nanolubricant and nanofluids including:
- Nanolubricants containing special nanoparticles for reduction of wear
- Nanolubricants containing specially design and synthesized nanoparticles for conditioning and polishing surfaces for lower friction through *in-situ* nanopolishing
- Cutting nanofluids that improve tool life and surface finish of the workpiece in sheet metal working and machining operations
- Nanolubricants, nanofluids and coolants with enhanced thermal conducting for improved heat transfer in addition to their improved lubrication and tribological properties
- Below-room-temperature and at-room-temperature gelling of nanofluids for dispersion stability and prolonged shelf life without particle settlement

Benefits of the Technology
This portfolio of technologies yields improvements to critical characteristics of lubricants and fluids used in tribological and thermal transfer applications. These improvements include lower wear and maintenance, lower friction, in-situ polishing of moving surfaces, and higher thermal conductivity. These technical improvements translate into more reliability, reduced energy consumption and lower cost of operation.
Also, the ever challenging poor suspension of nanoparticles in conventional nanofluids is overcome through gelling technologies that are introduced.
The gelling technologies provide prolonged shelf life for nano dispersions without settlement.
The initial higher cost of using the developed nanofluids and nanolubricants is economically justified by the lower cost of maintenance and part replacement frequency.

Potential Application for Technology
The potential applications for the developed technologies are as wide as the applications for lubricating oils such as engine and transmission oils, cutting fluids such as those used in sheet metal working and machining operations, and coolant used for heat transfer in heat exchangers.
The developed technologies improve important characteristics such as wear in lubricated sliding and rolling components which results in lower maintenance and lower operating cost. Also, the cutting fluids that utilize these technologies provide better lubrication and enhanced heat transfer that allow lower tool wear, higher cutting speeds, and better surface finish of the workpiece. The improved surface finish of formed, drilled, or machined parts can also result in longer fatigue life for components subjected to high cyclic stresses such as those encountered in aerospace applications.

Stage of development
This technology has been reduced to practice. Laboratory experiments and drilling operations have been performed to understand and establish the geometrical, morphological and materials characteristics of dispersed nanoparticles. Also, mechanical and chemically enhanced dispersion methods have yielded gelling

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capabilities that inhibits of nanoparticle particle movement in the gel, but can be easily converted into the fluid state at the time of use.

Pathway to technology being ready for licensing and/or product
Our cost analysis indicates that incorporating our technologies into the lubricating oil will add an initial additional cost of approximately $5 per gallon. At the same time, the reduction in wear ranges from 30-60% in our laboratory experiments. For cutting fluids, the additional cost per gallon is approximately $2-7 which includes the gelling process. The technology may also result in other tool wear reduction. We have also observed increased an increased thermal conductivity of 20% at an additional cost of $10 per gallon of a coolant.
The additional costs are well justified in comparison to the improvements in tribological and thermal properties.
As the production volume of nanofluids/nanolubricants is increased a sharp decline is the initial additional cost is expected.

Opportunity
Howard University is looking for commercial partners to further develop these technologies into commercial products.

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INVENTOR

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Professor
Department of Mechanical Engineering
Howard University

EDUCATION

Ph.D. Mechanical Engineering, Massachusetts Institute of Technology (MIT), 1994
M.S. and B.S. Mechanical Engineering, AMK University, 1988

SPECIALTY

Dr. Mosleh's research and development interest and activities focus on understanding the fundamental mechanisms of surface interactions from atomic to macroscopic scales and utilizing this understanding in development of new methods and products to manage friction, wear and lubrication. Some notable methods and products that he has developed include surface texturing techniques for maintenance –free journal bearings for high vacuum/high temperature environments, novel hybrid rolling bearings for high speed applications, nanolubricants for minimizing wear, in-situ nanopolishing through use of nanofluids, and below room temperature gelling of nanofluids for infinite shelf life.

The development of novel nanolubricants and nanofluids for tribological and thermal management is the key focus of Dr. Mosleh research during the past 5 years. Through research collaboration with the Boeing Company, he has investigated the mechanisms by which when specially designed and synthesized nanoparticles are dispersed in lubricating oils, cutting fluids, and coolants, they can yield significant improvements in tribological properties, tool life, surface finish, and heat transfer.

Dr. Mosleh has published over 80 papers in scientific journals and proceedings. He has received numerous awards including Rabinowicz tribology award, Editor's Choice Award by the Tribology and Lubrication magazine, ASME award, and distinguished faculty author award. In addition to his current position as Professor at Howard University, his professional appointments and services include Visiting Scientist at the Oak Ridge National Laboratory, Visiting Scientist at the Princeton Plasma Physics Laboratory, Guest Scientist at the National Institute of Standard and Technology (NIST), Advisory Board of the Mechanical Engineering Department at the University of Maine, Board of Directors of the American Society of Mechanical Engineers (ASME) of Washington DC section, Graduate Program Director at Howard University, Manager of MIT/Harvard-industry consortium on durability of total joint replacements at the Massachusetts institute of Technology (MIT).