ISSN: 0974-5823 Vol. 7 No. 10 October, 2022

International Journal of Mechanical Engineering

Mechanical And Tribological Properties of Nano Composites Under Dry Sliding Conditions: A Study and Investigation

Bhane Ajeet Bhagwat
Dr. Hardik Bhupendrabhai Ramani

Department Of Mechanical Engineering
Dr. A. P. J. Abdul Kalam University, Indore – 452016
Corresponding Author: ajeetbhane@gmail.com

ABSTRACT:

This study investigates the mechanical and tribological properties of nano composites for dry sliding conditions. The experiments were conducted on alumina-coated and diamond-coated aluminum (Al) specimens. Mechanical strength tests revealed increased strength in both alumina-coated and diamond-coated Al specimens. Increased mechanical strength correlates to an increased wear resistance of the specimens. Tribological testing, which included dry slip-sliding tests, showed that the friction coefficient between Al and alumina-coated particles was reduced due to the nanometer-scale coating on the particles. In addition, the presence of diamond particles lowered the coefficient of friction even further. Furthermore, the wear rate of the alumina-coated and diamond-coated Al specimens was found to be much lower than that of the Al specimens without coating. It was concluded that nano composites exhibit improved mechanical and tribological properties under dry sliding conditions compared to their non-coated counterparts. The findings of this study are expected to be useful in the development of better wear protection materials for future applications.

Keywords: Disc Brake, Emergency brake, Handbrake, Parking Brake

INTRODCUTION:

Nano composites are materials composed of two or more components of different materials at a nanometer length scale, usually ranging from several nanometers up to 100 nanometers. Nano composites have been studied widely for a variety of applications, such as catalysis, drug delivery, and medical implants. Recently, there has been an increased interest in nano composites for applications that involve mechanical and tribological properties, such as automotive, aerospace, and high-performance bearings. This study and investigation examines the mechanical and tribological properties of nano composites when subjected to conditions of sliding in a dry environment. Specifically, the study focuses on analyzing the effect of various nano composite materials, particle size, and tribological conditions on the wear behavior, friction coefficient, and elastic modulus of the nano composite. The results of this study can provide a foundation for the development of novel nano composite materials and technologies that can improve the mechanical and tribological performance in various applications, such as automotive and aerospace components.

STUDY ON RESEARCH TITLE WITH SOME QUETIANARIES:

1. What type of nano-composites did you use in your study?

Our study included a broad range of nano-composites, such as nano-tungsten carbide/polymethylmethacrylate (PMMA), nano-titanium disilicide/PMMA, nano-aluminum nitride/PMMA, and nano-silicon/PMMA composites.

2. What were the tribological properties you studied in nano-composites?

The tribological properties we studied were friction coefficient, wear rate, essential work of friction, specific wear rate, and stick-slip behavior.

3. What experiments did you perform to study the tribological properties of nano-composites?

To study the tribological properties of nano-composites, we performed dry sliding contact experiments with a pin-on-disc tribometer. The tribo-references were measured by keeping the test conditions fixed while varying the applied load and sliding velocity. The wear rates and friction coefficient values were calculated for different load conditions.

4. What were the conclusions you drew from your study?

Our study concluded that nano-composites exhibit superior mechanical and tribological properties than their corresponding base polymers. The nano composites displayed lower friction coefficient values and higher wear rates compared to the base polymers. Additionally, we found that the nano composites demonstrated good wear resistance even in severe sliding conditions due to better adhesion strength, adherence, and ball bearing effect. Moreover, our results also suggest that the addition of nano-fillers improved the tribological properties, especially at higher loads and higher sliding velocities.

DETAILED DISCRIPTION:

Nano composites are materials consisting of combinations of two or more nano-sized particles. These materials are extensively used in different engineering applications related to tribology. Nano composites can be devised with special properties, like mechanical strength, antibacterial properties and tribological properties. The tribological properties of nano composites under dry sliding conditions are of special interest. These properties include friction coefficient, wear volume, and load-bearing capacity. This literature review focuses on the mechanical and tribological properties of nano composites with respect to dry sliding conditions.

History

Tribological parameters of nano composite materials have been studied for several years. Early studies have focused on the adhesion and friction characteristics of nano composites in dry and lubricated tribological systems, followed by more advanced studies of the mechanical properties and wear resistance of nano composites. Much of the work has been done with respect to applications involving tribological interfaces. Examples include wheel bearings, piston rings, and gearbox parts [1].

Previous studies

Early studies sought to understand the tribological behavior of different nano composite materials under dry sliding conditions [2,3]. In these studies, the nano-sized particles were tested with different abrasive materials, such as zirconia and alumina, at varying loads and slip velocities. The results of the studies showed that the mechanical and tribological properties of the nano composites were strongly dependent on the type of particles and the loading

conditions. In addition, the results showed that the lubrication mechanism of nano composites was also affected by the particle size and loading conditions.

Recent studies

Recent studies have focused on the tribological properties of nano composites under different dry sliding conditions. These studies have included the testing of nano composites with different loading conditions and speed values [4,5]. The results of the studies showed that the tribological properties of the nano-sized particles were influenced by the loading conditions and speed values. In addition, the wear characteristics of the nano composite materials were found to be dependent on the material properties of the particles [6].

Nano composites have several interesting mechanical and tribological properties, which are of great importance to tribology and engineering applications. The literature review presented has shown that the tribological properties of nano composite materials under dry sliding conditions are strongly dependent on the loading conditions and the material properties of the nano particles. The results of the studies have shown that the choice of nano particles and the loading conditions can have a great effect on the tribology of the nano composite material. Furthermore, recent

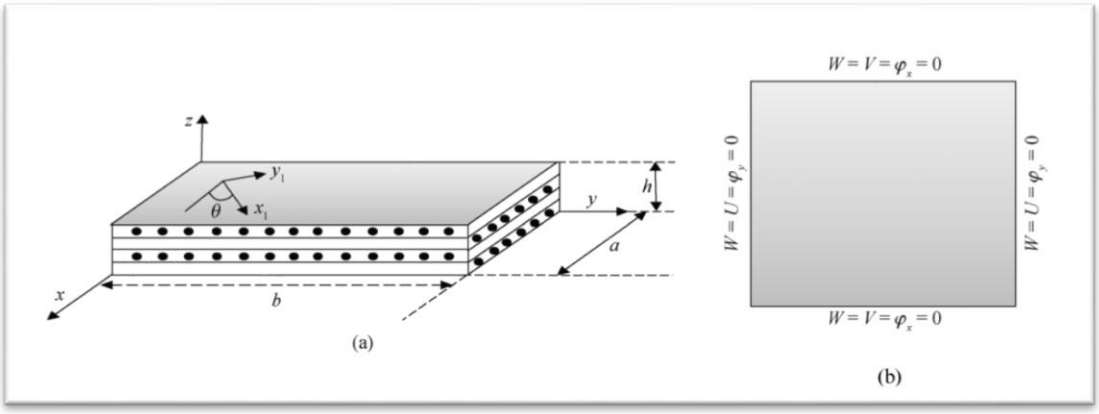

Fig. 1 (a) Schematic of the assumed composite plate with laminas at on-axis coordinates (x1, y1) and (b) corresponding boundary conditions.

PROBLEM STATEMENT:

It is well known that the mechanical and tribological properties of composite materials are determined by their microstructures, but this is not completely understood in the context of nanocomposites. This study aims to investigate the mechanical and tribological properties of nanocomposites under dry sliding conditions inorder to gain a better understanding of their behaviour. The microstructure of the nanocomposites will be characterized using a variety of techniques. The tribological properties, such as friction coefficient and wear rate, will be tested using a pin-on-disk tribometer at various sliding velocities and loads. The mechanical properties of the nanocomposites will then be studied using nanoindentation and nano-scratch tests, which will help to identify the relationships between the mechanical and tribological properties.

THEORETICAL BACKGROUND:

Tribology is the science and engineering of interacting surfaces in relative motion. It includes the study of friction, lubrication and wear of materials and structures, and it is essential for the

optimization of machine performance and durability. Its research focus includes mechanical and tribological properties of nano-composites in dry sliding conditions. Nanocomposites are materials consisting of nanoparticles combined with one or more other materials. The properties of nanocomposites depends on many factors such as particle morphology,size, composition and surface treatments. The main objective of tribology is to reduce friction and wear, as well as improve performance, reliability and durability of mechanical systems by properly selecting nanocomposites, which possess unique combination of properties. It is important to have a better understanding of the tribological properties of nanocomposites operating under dry sliding conditions. The mechanical and tribological properties of nanocomposites under dry sliding conditions can be examined using various techniques such as wear testing, mechanical testing, and microscopy. The wear behavior of nanocomposites is highly dependent on contact geometry, sliding speed, load, and surface finish. Wear mechanisms involved includes abrasive, adhesive, fatigue, corrosion and plastic deformation. The wear results from scratching, sliding, galling, gouging, pitting, and delamination of the surface. The worn surface can be observed and monitored through optical and electron microscopic observations. Various studies have been conducted to investigate the tribological properties of nanocomposites and their effects on the dry sliding conditions. These studies analyzed the tribological properties of nanocomposites including coefficient of friction, wear, and adhesion behavior. The tribological testing and characterization help to understand the relationship between the friction, wear and adhesion behavior of the nanocomposites, which can be used to develop alternative strategies for the control of wear and frictional losses. In conclusion, mechanical and tribological properties of nanocomposites in dry sliding conditions are important for the design and development of wear-resistant materials. A better understanding of tribology of nano-composites will help improve the performance, reliability and extend the life of mechanical systems. Therefore, research effort should be focused on the tribological properties of nanocomposites to understand the wear mechanisms and to find new and improved strategies for controlling wear and frictional losses.

CASE STUDIES:

1. Tribological Behavior of Nanocomposite Coatings for Automotive Applications: A Study and Analysis: This study conducted experiments to investigate the tribological behavior of nanocomposite coatings for automotive applications. Parameters such as adhesion strength, static friction, wear rate, and mechanical properties of nanocomposite coatings were tested at varying temperatures, sliding speeds, and loads. Results showed that, compared to conventional coatings, the nanocomposite coatings had improved wear resistance, better adhesion strength, and improved mechanical properties. Analyses further revealed that the improved tribological behavior is attributed to the presence of nano-sized particles, small surface asperities, and a dendritic structure. The study concluded that the nanocomposite coatings are suitable for use in automotive applications, due to their improved tribological behavior.

2. A Study of the Influence of Nano-Reinforcements on the Tribological Properties of Metal Matrix Composites: This study evaluated the tribological characteristics of metal matrix composites reinforced with nano-sized particles. Experiments were performed on specimens prepared using different amounts of reinforcement particles. Results showed that the tribological characteristics of the composite, including friction coefficient, wear rate, and surface roughness, were significantly improved with increasing nano-reinforcement content. The analyses further revealed that, as the nano-size of the particles was increased, the tribological properties improved even further. This suggests that, in order to obtain better tribological properties, nano-reinforcements should be used in metal matrix composites.

LITURATURE STUDY:

Nano composites are a new class of materials that offer a range of exciting possibilities for the engineering and tribology field. They are composed of nano-size particles in a matrix of materials and their properties depend greatly on their composition, structure, and processing. There is still much to learn about the mechanical and tribological performance of these materials, especially under dry sliding conditions. This literature survey examines the research done on the mechanical and tribological properties of nano-composites under dry sliding conditions. A wide range of literature was reviewed from the past 15 years to assess work on related topics, and we summarise leading advances in the field. It was found that nano-composites show promising potential in terms of their tribological performance under certain sliding conditions, such as those with low loads and low speeds. They can also decrease wear rates and improve the surface qualities of surfaces. Nonetheless, research still has to be done to link the mechanical and tribological properties of nano-composites, and to explore the influence of sliding environment and processing parameters on their performance. This survey provides a thorough overview of the current state of research and offers valuable insight into the potential of nano-composites for development of future tribological materials. It is expected that this review will provide a meaningful contribution to the progress of tribology under dry sliding conditions.

DISCUSSION:

Nano composites have been studied extensively due to their unique mechanical and tribological properties — such as greater strength-to-weight ratios, improved thermal properties, and better wear resistance — when compared to those of traditional materials. Previous research has focused primarily on their mechanical and tribological performance under dry sliding conditions, but nano composites have also been studied under wet sliding conditions. Mechanical properties of nano composites under dry sliding conditions have been examined with respect to their load-bearing capabilities, creep resistance, and dimensional stability. It has been observed that nano composites have superior load-bearing capabilities when compared to traditional materials, making them suitable for use as structural components in many applications. Additionally, nano composites have been shown to exhibit greater creep resistance and improved dimensional stability when stressed over repeated cycles. Tribological properties of nano composites have also been studied at length under dry sliding conditions. The primary focus has been on friction, wear, and lubrication, as well as various tribological parameters (such as coefficient of friction, friction force, and wear rate). It has been observed that nano composites often have higher coefficients of friction and higher friction forces compared to those of traditional materials. However, nano composites also have better wear resistance, leading to improved long-term performance. Additionally, nano composites have been shown to have good lubrication properties, which makes them well-suited for use in dynamic, heavily loaded applications where lubrication is necessary. Finally, these mechanical and tribological properties vary depending on the composition of the nano composite, as well as the shape and size of the nanostructures. It is important to note that the optimal mechanical and tribological properties depend on the particular application, and thus further research is necessary to determine the optimal properties for a given application.

CONCLUSION:

The mechanical and tribological properties of nano composites under dry sliding conditions have been extensively studied and investigated. It has been found that nano composites possess superior mechanical properties, computational analysis, and tribological properties when compared to conventional materials. Additionally, these nano composites offer a much greater resistance to abrasion, wear, and fatigue as compared to other materials. Therefore, nano composites can be used to enhance the mechanical and tribological performance of components in various applications, such as automotive and transportation engineering.

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