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Friction and Wear Properties of Si_3N_4/TiC Ceramic Composite under Nano Lubrication

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Abstract. The present research evaluated the tribological behavior of Silicon Nitride based composite reinforced with 1 wt. % of Titanium Carbide under dry and lubrication conditions. The lubricant base oil used in this study is 85W140; with nanoparticles additives poly tetra flouro ethylene and Copper (PTFE & Cu) Nanoparticles were added in the base oil to review the performance of the nanoparticles as additives. Ball-on-disc wear tests were conducted to explore the effects of Nano additive in lubricant for ceramic-ceramic tribo-pair. Results showed that friction and wear decreased using nanoparticle in the lubricant oil, as compared to, dry as well as base lubricant oil conditions. It was reported that 0.1 wt. % of PTFE Nano particles and 0.3 wt. % of Cu Nano particles shows minimum value for the coefficient of friction (COF). Rheological studies were also done on these lubricants samples. The findings from the present work encourage the modification of nanoparticle based lubricant to improve the friction and wear properties and to improve the life of the component.

1. Introduction

Friction, wear and lubrication are the main aspects of the tribological properties/characterization. Ceramics are the special class of materials having a wide range of applications from pottery to furnace brick or hard refractory inorganic compounds, which are formed by heating the base material in powder form to a high temperature and controlled atmosphere for solid state reaction. Ceramic materials exhibit properties that make them suitable candidates for a number of industrial and engineering applications. Advanced structural ceramics differ from conventional ceramic consumer goods in that they are made from extremely pure, microscopic powders that are consolidated at high temperatures to yield a dense, durable structure. Compared with the metals advanced structural ceramics are the material which possesses high strength and hardness, good corrosion resistance, good chemical resistance and good wear resistance than the most metals. Also with the merits of relative high strength compared with its low density, low coefficient of friction, excellent anti-corrosion capability, engineering ceramics are widely used as wear resistant material in extremely harsh environment condition where poor or no lubrications available, such as bearing in aerospace machines, ocean engineering machines, food processing machinery and mechanical equipment used in high temperature and corrosive environment. For enhancement in the mechanical properties, tribological properties, chemical stability etc., combinations of materials are most commonly used in present and have a very bright future. These combinations of materials are – laminates, composites and matrices of different types to provide strength, corrosion resistance, dimensional stability, high temperature sustainability and other properties that are not present in conventional form of materials. M. Belmonte observed the wear behavior of textured silicon nitride (Si_3N_4) ceramics with aligned microstructures under abrasive wear conditions [1]. He performed dry reciprocating self-mated ball-on-flat disc wear tests to study the influence of different micro structural plane/orientation combination on the Si3N4 tribological behavior. He found that the textured materials showed superior wear resistance than non-textured reference Si_3N_4 for the whole range of loads and contact pressures, 5 – 50 N and 1.7 – 3.6 GPa, respectively, with an increase of about 70% for the maximum applied load. J.M. Carrapichano observed the tribological behavior of Si_3N_4 – BN composites performing unlubricated sliding tests by pin-on-disc were carried out with three grades of composite materials with 10, 18 and 25 vol% of BN [2]. He found that the addition of BN to