TRIIBOLOGICAL BEHAVIOR OF CUO@RGO NANOPARTICLES UNDER DIFFERENT SLIDE-ROLL RATIO

S. M. Alves1 [a*] and A. Morina[b]

*corresponding.author salete.alves@ufrn.br
[a] School of Sciences and Technology, Federal University of Rio Grande do Norte, Av. Senador Salgado Filho, 3000 zipcode 59078-900, Brazil.
[b] Institute of Functional Surfaces, School of Mechanical Engineering, University of Leeds, LS2 9JT, Leeds, United Kingdom

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ABSTRACT

High gearbox failure rates were observed in wind turbines due to severe operating conditions, generating surface damage on contacting components, such as micropitting, spalling, scuffing, excessive abrasive wear, and corrosive wear. These surface damages are affected by the type and formulation of the lubricating oil. In this sense, nanolubricants have been considered as a potential lubricant additive for this application [1]. The nanoparticles detached during the friction process could easily combine with the friction pair to form a compact transfer film and accumulate on the worn surface, creating a complete lubrication film and improving the tribological performance of lubricants [2]. The aim of this paper is to develop core-shell nanoparticles by combining CuO (core) and reduced graphene oxide (shell) as lubricant additives and understand their action under different slide-to-roll ratios.

The tribological performance of the developed nanoparticles was investigated in a Mini-Traction Machine (MTM). All MTM measurements were taken at 60 N of applied load and 50 mm/s of entrainment speed, yielding a contact pressure of 1.2 GPa. The SRRs evaluated were 50 and 200%. The test specimens were highly polished 52100 steel, a ball of ¾ inch, and a disc of 46 mm diameter. The nanoparticles were dispersed in PAO 6 base oil at 0.05 and 0.1wt% concentrations. After the MTM tests, the worn tracks were characterized through WLI (white light interferometry), SEM (scanning electrical microscopy), and Raman Spectroscopy.

The results showed that nanoparticle addition improves the tribological performance of base oil, mainly in terms of wear reduction. Fig.1 displayed the wear track for different concentrations of NNP, and 0.05% of NNP was sufficient to reduce the wear significantly. Friction is reduced with the addition of nanoparticles. However, this reduction is more significant in SRR 200%, which is a pure sliding condition.

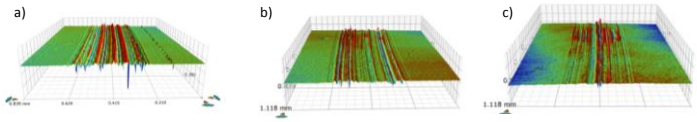

Fig.1 3D images of wear track in disc surface a) base oil, b) 0.1% of NNP and c) 0.05% of NNP at SRR 200%.

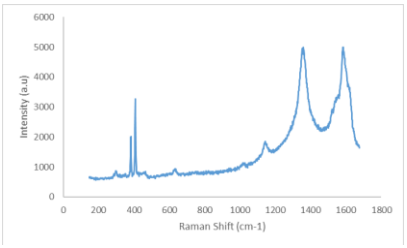

Figure 2: Raman Spectra of worn surface for lubricant with 0.1% of NNP at SRR 50%.

Also, Raman analysis indicated tribofilm formation from deposition of reduced graphene oxide on the worn surface, even in low concentration (Fig.2). The tribofilm formation and thickness were independent of SRR, while wear depth increased with SRR. The results show that PAO 6 base oil can have tribological properties by adding a small amount of CuO@rGO, around 0.05% wt.

REFERENCES

[1] Greco, K. Mistry, V. Sista, O. Eryilmaz, A. Erdemir, Friction and wear behaviour of boron based surface treatment and nano-particle lubricant additives for wind turbine gearbox applications, Wear, Volume 271, Issues 9–10, 2011, Pages 1754-1760. https://doi.org/10.1016/j.wear.2010.11.060.

[2] Chen, Hao, Lin Zhang, Mengyu Li, and Guoxin Xie. 2020.Synthesis of Core–Shell Micro/Nanoparticles and Their Tribological Application: A review" Materials 13, no. 20: 4590. https://doi.org/10.3390/ma13204590