EFFECT OF CHAIN LENGTH ON TRIBOLOGICAL PERFORMANCES OF MXENE SOLVENT-FREE NANOFLUIDS AS ADDITIVES FOR WATER-BASED LUBRICANTS

Shuwen Liu [a,d], Jing Tang [c], Wen Liu [c], Zhangpeng Li [a,b,d *], Jinqing Wang [a,b]
*zhangpengli@licp.cas.cn
[a] State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences,
Lanzhou 730000, China
[b] Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences,
Beijing 100049, China
[c] College of Environment and Safety Engineering, Qingdao University of Science and Technology,
Qingdao 266042, China
[d] Qingdao Center of Resource Chemistry & New Materials,
Qingdao 266000, China

KEYWORDS
Lubricant additives; Friction; Fluid lubrication; MXene

ABSTRACT

Solvent-free nanofluids are increasingly gaining attention in the lubrication field. Previous studies on solvent-free nanofluids in tribology have primarily focused on shell structures with ionic linkage, and their lubrication mechanism was attributed to the formation of a unique double electric layer of ionic liquids on the sliding surface. However, the lubrication mechanism for the solvent-free nanofluids with covalent linkage shells remains clear.

Here, three kinds of solvent-free covalent MXene nanofluids (MXene NFs: code as M1000 NFs, M2070 NFs, M3085 NFs) with diverse canopy chain lengths were successfully synthesized. Effects of chain lengths of shell on their physicochemical properties and tribological performance were investigated. Our findings demonstrate that the as-prepared MXene NFs presented rather stable antioxidant ability even after standing for 300 days (M1000 NFs), while the antioxidant ability decreases as the chain length increases. Moreover, when used as water-based lubricant additives for Cu/ZrO_2 friction pairs, the different shell chain lengths lead to different optimal additions and tribological behaviors of MXene NFs additives. The M3085 NFs additive exhibits lower friction reduction performance than the M2070 NFs and M1000 NFs, and the lowest friction coefficient can be obtained with an addition of 0.25 wt%. A longer shell chain facilitates the formation of a thick adsorption layer and hence reduces friction. Wear resistance, unexpectedly, was little affected by the chain length, but greatly depend on the amount of MXene core. When the content of MXene NFs additive is more than 1.0 wt%, the wear volume has over 80% decrease compared to that of pure water. As the content of MXene increases, a dense tribofilm structure is formed, significantly enhancing wear resistance. This research provides fundamental insights into the underlying mechanisms of chain length on the tribological properties of solvent-free nanofluids for water lubrication systems.

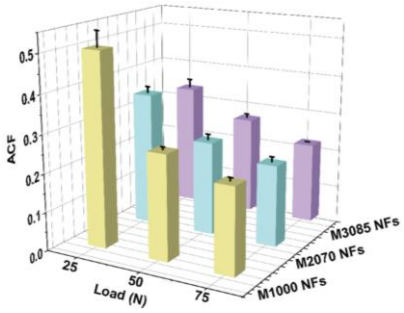

Fig.1 ACF of water with 0.5 wt% M1000 NFs, M2070 NFs, and M3085 NFs (Cu/ ZrO_2, 25 Hz, 1 mm, 25 ℃)

ACKNOWLEDGMENTS

This work was supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (Grant No. XDB 0470301), and CAS "Light of West China" Program.

REFERENCES

[1] Tang, J., Liu, S., Liu, W., Wang, Y., Li, L., Li, Z., and Wang, J., "Comparative study on tribological performance and mechanism of eco-friendly solvent-free covalent MXene nanofluids in glycerin and polyethylene glycol," Tribology International, 190, 2023, 109051.