Synergistic effects of nitrogen-containing functionalized copolymer and silicon-doped DLC for friction and wear reduction

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Abstract

Lubrication systems based on polymer additives and diamond-like carbon (DLC) coatings have long been recognized for their potential to reduce friction and wear in industrial applications. However, achieving optimal compatibility between additives and DLC surfaces has remained a challenge due to the low reactivity of traditional lubricants with DLC. Recent advancements in chemical modifications, such as silicon doping in DLC and functionalization of copolymers with nitrogen-containing groups, offer a promising pathway to address this limitation.
This study investigates the synergistic effects of functionalized copolymers and silicon-doped DLC (Si-DLC) films in reducing friction and wear. Experimental tribological tests reveal that the nitrogen-functionalized copolymers significantly improve lubrication, reducing friction and wear by forming a tribofilm on Si-DLC surfaces. Ab initio simulations highlight the critical role of N-Si interactions in promoting chemisorption of the additives, a key step in tribofilm formation. These findings demonstrate how tailored chemical modifications to both lubricants and substrates can enhance tribological performance, paving the way for innovative lubrication solutions in automotive and manufacturing industries.

(1) Omiya, T., Pedretti, E., Evaristo, M., Cavaleiro, A., Serra, A. C., Coelho, J. F. J., Ferreira, F., & Righi, M. C., Synergistic effects of nitrogen-containing functionalized copolymer and silicon-doped DLC for friction and wear reduction. Tribology International vol. 200 110183 (2024) (https://doi.org/10.1016/j.triboint.2024.110183)

These results are part of the "Advancing Solid Interface and Lubricants by First Principles Material Design (SLIDE)" project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (Grant agreement No. 865633).

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