2D nano-materials beyond graphene: from synthesis to tribological studies

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Abstract

Continuously increasing global population and, therefore, energy consumption as well as diminishing resources combined with environmental aspects such as global warming ask for more efficient, sustainable and reliable processes/applications of mechanically moving parts. Especially under harsh conditions, such as high temperatures, vacuum or dry contacts, 2D layered nano-materials used as solid lubricants have demonstrated to be promising candidates to ensure low friction and wear over the entire component's lifetime. Therefore, this review article aims at summarizing the existing state-of-art regarding solid lubricants with a special emphasis on 2D layered nano-material beyond graphene including graphene oxide, reduced graphene oxide, MoS2, WS(2)as well as Ti(3)C(2)T(x)MXene nanosheets. Initially, experimental approaches allowing for a large-scale and layer-dependent synthesis are reviewed for each nano-material. Subsequently, their friction and wear mechanisms at the nano-scale are discussed. Afterwards, the ability to improve friction and wear are reviewed when using the aforementioned 2D nano-materials either as a solid lubricant, lubricant additive under lubricated conditions or reinforcement phase in composite materials. Finally, the existing challenges and shortcomings of each 2D nano-material are discussed before deriving the general conclusions and giving some future research directions.

Keywords

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