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# MXene as a multi-functional 2D reinforcement in self-lubricating PEEK-based composites

**Mingyu Fu, Lili Xue, Cheng-Feng Du***
State Key Laboratory of Solidification Processing, Center of Advanced Lubrication and Seal Materials, Northwestern Polytechnical University, Xi'an, Shaanxi 710072, P. R. China

## INTRODUCTION & AIM

The MXene material has been widely evaluated as 2D reinforcement in polymer-based composites due to their large specific surface area, abundant surface chemical bonding sites, and robust layer bonding. However, when turning to the polymer-based solid lubricant, the MXene usually not only displays crucial roles on the aspects of mechanical properties but also contributes to the frictional processes as well. Particularly, different from the traditional van der Waals crystals (graphite, $MoS_2$, etc.), the MXene nanoflakes have much stronger interlayer interactions. Therefore, it is urgently needed to clarify the detailed mechanism of MXene on self-lubricating and anti-wear performances. Herein, by introducing $Ti_3C_2T_x$ MXene in a poly(ether-ether-ketone) (PEEK) and poly(tetra-fluoroethylene) (PTFE) composites, a series of composites with different ratios of components are prepared, and their self-lubricating performance is evaluated under dry-sliding conditions.

## METHOD

The PEEK-PTFE and PEEK($Ti_3C_2T_x$)-PTFE composites were prepared by hot-pressing a powder mixture of each constituent. The compressive properties of composites were tested by the CMT5150 universal test machine (MTS Systems) in accordance with GB/T 1041–2008. The linear reciprocating friction and wear test of the PEEK($Ti_3C_2T_x$)-PTFE composites at room temperature were measured by the UMT multifunctional tribometer (Bruker) against $ZrO_2$ ball (ϕ6 mm, G20, Shanghai JZN bearing Co., Ltd).

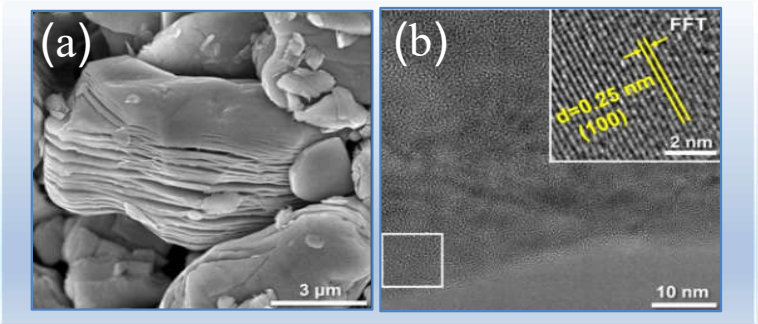


**Fig. 1** SEM and TEM of $Ti_3C_2T_x$: (a) SEM image and (b) HRTEM of $Ti_3C_2T_x$.

## RESULTS & DISCUSSION

The filling of $Ti_3C_2T_x$ increased the PTFE transferfilm on the $ZrO_2$ balls. The strong Ti-O-Zr covalent bond between Ti3C2Tx and $ZrO_2$ and the formation of Ti-Zr metallic bonds make $Ti_3C_2T_x$ more easily transferred to $ZrO_2$ than PTFE and PEEK. Meanwhile, the sliding-induced peroxide radicals and carboxyl groups on the PTFE molecular chain also facilitate the interaction with the hydroxyl groups on the surface of $Ti_3C_2T_x$. On the other hand, the strong interaction between the $Ti_3C_2T_x$ MXene and the PEEK or PTFE enhances the cohesion of the composite.

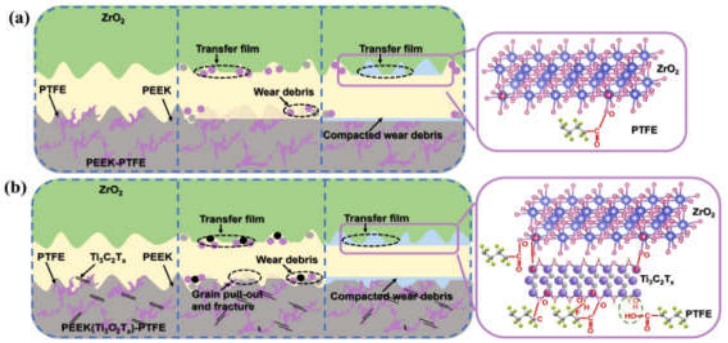


**Fig. 2** Lubrication and anti-wear mechanism of PEEK-PTFE and PEEK($Ti_3C_2T_x$)-PTFE composites.

## CONCLUSION

A positive role of $Ti_3C_2T_x$ nanoflakes on tribofilm formation is probed, which includes improving the interfacial bonding between the polymer grains, enhancing the adhesion of PTFE chains on the counterpart $ZrO_2$ balls, and dispersing the stress on counter surfaces during friction. Eventually, the MXene-reinforced PEEK-based composites display both a lower coefficient of friction and wear rate than the previously reported PEEK-PTFE composites, which show comparable self-lubricating performance with pure PTFE and over 100 MPa. The current studies illuminate the crucial roles of MXene in PEEK-based solid lubricants and pave the way of construction novel solid lubricants as well.[1,2]

## FUTURE WORK / REFERENCES

**References:**
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[2] L. Haoting, X. Lili, Z. Jiewen, Y. Hong, D. ChengFeng, L. Xuqing, *Tribology* **2026**, *46*, 1-15.
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