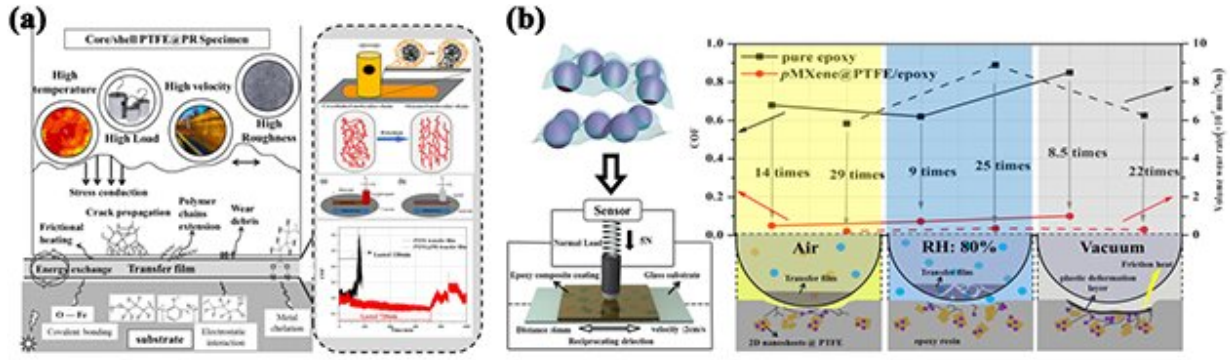
Developing core-shell functional composites with excellent self-lubrication properties

September 30 2021, by Zhang Nannan



The preparation and friction transfer mechanism of PTFE-based core-shell composite lubrication materials with environmental adaptability for multiple working conditions. Credit: LICP

As high-end mechanical equipment put forward increasingly demanding requirements on the high performance characteristics such as bearing-load capacity, working environment and service life of self-lubricating moving parts, traditional lubrication materials are facing applied limitations under harsh and multi-environmental service conditions. Therefore, development of functional lubrication materials with low friction, long life and multi-environmental adaptability has become a leading trend in recent years.

Recently, two research teams at the Lanzhou Institute of Chemical

Physics of the Chinese Academy of Sciences carried out a joint research on the design and functional assembly of core-shell functional composites by virtue of interface interactions between different components.

A series of studies, in particular, were performed on the structural design , control strategies, regulation strategies, lubrication mechanisms and wear-resistance mechanisms of core-shell composites.

According to the researchers, the results provide an experimental basis and theoretical guidance for the design of strong and flexible functional lubrication materials with multi-environmental adaptability.

Using a combination of in-situ polymerization and hot-pressing techniques, the researchers prepared core-shell polytetrafluoroethylene@phenolic resin (PTFE@PR) composites. These composites demonstrated excellent self-lubrication and wear-resistance properties under different temperatures, loads, speeds and degrees of roughness of the upper counterpart. Improved tribological performances were derived from the enhancement and formation of long-life composite transfer films with long-range, ordered, bi-phase polymer chains via friction induction.

In addition, a novel lubricating additive was designed and synthesized via the self-assembly of wrapped PTFE nanoparticles by exfoliated MXene ($Ti_3C_2T_x$) sheets. Then, pMXene@PTFE core-shell hybrids were introduced into the epoxy coating.

The research results show that pMXene@PTFE not only alleviates the oxidation of MXene sheets but also synergistically optimizes lubrication and wear-resistance capabilities. Such epoxy-based composite coatings present excellent friction-reduction and wear-resistance properties in dry air, humid air and vacuum environments, making stable, multi-

environmental binary composite coatings a reality.

In summary, core-shell structured lubrication materials have broad prospects for application in the design of synergistic composites at the micro level with different functional components, as well as for the development of multi-environmental, adaptive functional lubrication materials.

Related research results have been published in *Tribology International* and *Carbon*, respectively.

More information: Yawen Yang et al, Core-shell polytetrafluoroethylene @ phenolic resin composites: Structure and tribological behaviors, *Tribology International* (2019). DOI: 10.1016/j.triboint.2019.106092

Yawen Yang et al, Environmentally-adaptive epoxy lubricating coating using self-assembled pMXene@polytetrafluoroethylene core-shell hybrid as novel additive, *Carbon* (2021). DOI: 10.1016/j.carbon.2021.07.102

Provided by Chinese Academy of Sciences