



Development and engineering application of MXene-based anti-corrosion/wear resin coating

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The waterborne epoxy resin coatings suffer from drawbacks such as high porosity in spatial structures, poor resistance to the spread of corrosive media, and unsatisfactory tribological properties, significantly hindering their further application in practical engineering. Two-dimensional (2D) nanofillers can significantly enhance the protective performance of epoxy coatings due to its small size effect, high mechanical properties, easy interlayer shear, and impermeability. Among them, 2D Ti₃C₂T_x MXene, with high specific surface area, excellent mechanical properties, high electrical conductivity, and abundant surface functional groups that are easily tunable, demonstrates immense potential in improving the protective properties of waterborne epoxy resin coatings. However, to fully leverage the anti-corrosion and wear-resistance advantages of Ti₃C₂T_x hybrid epoxy coatings in harsh environments and meet the comprehensive protective performance requirements of anti-corrosion/wear for modern and future equipment, there are still a series of challenges to overcome. Currently, we primarily focus on enhancing the protective performance of Ti₃C₂T_x-based polymer coatings from the following aspects: (1) Enhancing the dispersion stability and compatibility of Ti₃C₂T_x nanosheets with the polymer matrix; (2) Inhibiting/utilizing the high electrical conductivity of Ti₃C₂T_x nanosheets; (3) Achieving oriented arrangement of Ti₃C₂T_x nanosheets in the resin matrix; (4) Intelligentizing Ti₃C₂T_x MXene. Design principles for functionalized Ti₃C₂T_x-based resin coating systems are established and the interaction between Ti₃C₂T_x-based composite resin coatings and multiple environmental factors are explored. The protective performance of Ti₃C₂T_x composite epoxy resin coatings are systematically investigated and the protection and failure mechanisms of the composite coatings are elucidated.