

## Oxidase-Functionalized Levofloxacin Carbon Dot Films as Emerging Marine Antifouling Materials for Titanium Alloys

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**Abstract** Considering the extensive application of titanium alloys in naval seawater pipelines and their susceptibility to marine biofouling, this study has successfully developed carbon nanodots (CDs) derived from levofloxacin as a precursor. These carbon dots, as a new type of metal-free artificial nanoenzyme, were modified with a silane coupling agent and combined with organic monomers using ultraviolet (UV) curing technology to form a film in situ on the surface of titanium alloys. The film not only retains the bactericidal properties of levofloxacin but also exhibits catalytic activity similar to that of oxidases, effectively inhibiting the formation of marine bacterial biofilms and the adhesion of diatoms. After a two-month real-sea hanging panel experiment, the film showed superior antifouling effects compared to the unmodified titanium alloy surface, providing an effective protective strategy for the long-term application of titanium alloys in marine environments, with significant scientific and application value.

**Keywords** Titanium alloys; marine biofouling; levofloxacin-modified carbon nanodots (CDs); oxidase-mimicking; antifouling film.