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MULTIFUNCTIONAL NANOFIBER NETWORKS FOR MARINE SELF-HEALING PROTECTIVE COATING

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Abstract. Intelligent self-healing coatings are at the forefront of corrosion protection research for marine engineering globally. We present innovative approaches using functional nanofibers to create advanced self-healing coatings. One strategy employs photothermal and corrosion self-healing based on multifunctional fibers. Electrospun fibers act as templates where photothermal agents and tannic acid, a corrosion healer, form a core-shell structure. These fibers, embedded in a thermoplastic resin, yield a responsive self-healing coating. When damaged, the fibers release healing agents that react with metal ions, filling cracks. Sunlight triggers photothermal agents, healing damage within 100 seconds. Another approach combines nanofibers with corrosion indicators for visible damage detection. These fibers, integrated into an epoxy resin, release indicators upon cracking, signaling corrosion and enabling timely repairs in marine environments.

Keywords: nanofibers; corrosion; self-healing; coating.

Intelligent self-healing coatings are a focal point in corrosion protection research for marine engineering, gaining traction both nationally and globally. We delve into two innovative strategies employing functional nanofibers to create these advanced coatings [1].

The first strategy focuses on a self-healing coating that combines photothermal therapy and corrosion healing [2]. Here, electrospun fibers serve as templates for integrating photothermal agents and tannic acid, a corrosion healer, resulting in a core-shell structured functional fiber (Fig. 1). These fibers are incorporated as fillers into a thermoplastic resin, producing a responsive self-healing coating upon curing [3]. When this coating sustains damage, the healing agent within the fibers is released, reacting with ferrous ions from metal corrosion to fill the cracks. Concurrently, exposing the damaged area to simulated sunlight activates the photothermal agents in the fibers, converting light to heat and facilitating rapid healing within a mere 100 seconds.

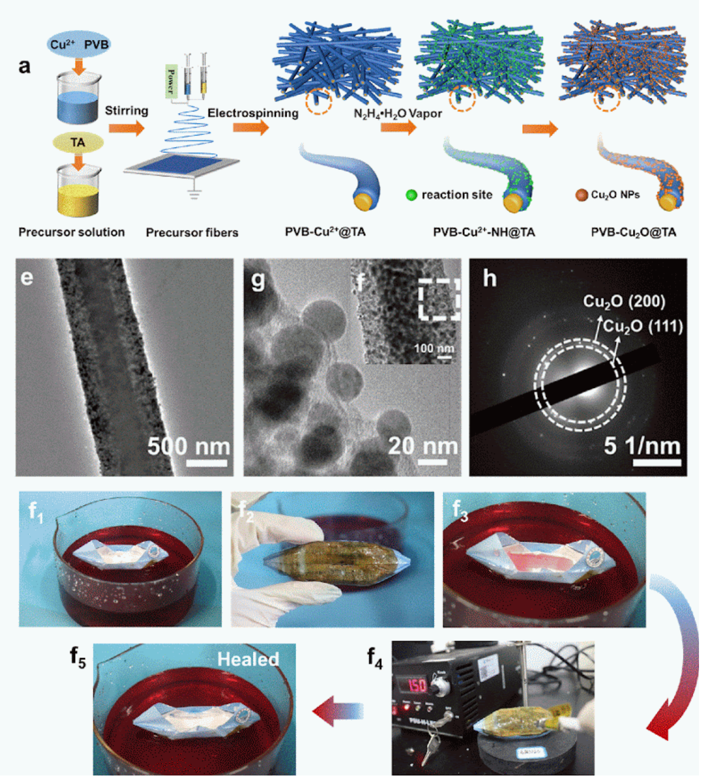

Fig. 1. First strategy for the formation of a functional fiber with a core-sheath structure

The second strategy introduces a composite coating with nanofibers that offer dual functionalities: visible indication and damage healing. In this approach, corrosion indicators are encapsulated within electrospun fibers, which are then blended with an epoxy resin as fillers [4]. When the coating experiences cracks, these encapsulated indicators are released, interacting with ferrous ions to form a red complex (Fig. 2). This complex serves as an early warning signal, indicating corrosion onset and signaling the need for repairs. Moreover, the use of chitosan as a shell material enhances the slow release of phenylenediamine, further bolstering the coating's healing capabilities.

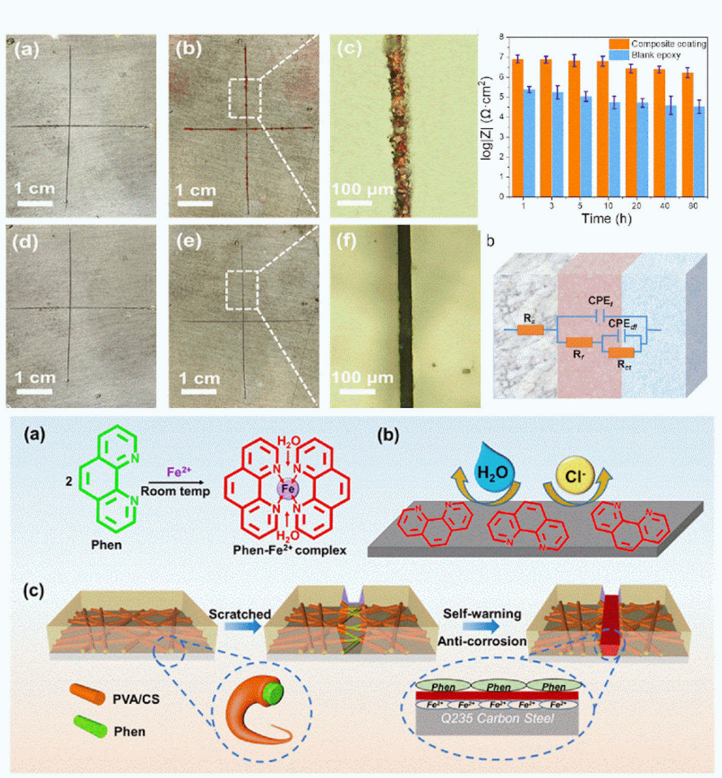

Fig. 2. Second strategy - formation of a red complex, which indicates corrosion

Applying this composite coating to carbon steel surfaces enables timely and precise detection of damage in marine environments during real-world production processes. The integration of corrosion indicators not only facilitates early damage detection but also ensures that repairs can be initiated promptly, minimizing potential risks and extending the lifespan of marine equipment.

Generally, these strategies showcase the potential of functional nanofibers in revolutionizing corrosion protection for marine engineering. By leveraging the unique properties of these nanofibers, we can develop coatings that not only heal themselves but also provide early warnings of damage, offering a proactive approach to maintaining and preserving marine equipment.

CONCLUSION

There are two main strategies of self-healing coatings action considered. Advanced self-healing coatings use electrospun fibers to integrate photothermal agents and tannic acid for corrosion healing, forming a core-shell structure. These fibers, embedded in thermoplastic resin, create a responsive coating. Upon cracking, healing agents react with metal ions, filling cracks, and sunlight triggers rapid healing within 100 seconds. Another coating incorporates corrosion indicators in electrospun fibers within epoxy resin, releasing indicators upon cracking. This provides early detection of corrosion in marine environments, aiding timely repairs.

References

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