

3D printing of living microbial coating for metal corrosion protection

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Abstract

The corrosion failure of marine engineering materials leads to significant economic losses and may trigger safety accidents. Traditional corrosion prevention strategies have been hindered by their environmental hazards, complex processes, and high costs. Recently, the application of living microbes for corrosion protection has attracted much attention, but this approach is limited by the dynamic nature of microbial biofilms. Herein, we designed a bio-ink composed of sodium alginate, gelatin, and sodium lignosulfonate by screening for adhesive strength and mechanical properties. By incorporating *Vibrio natriegens* with strong mineralization capabilities, a living coating that exhibits excellent corrosion protection performance was developed. It was corroborated by electrochemical corrosion tests, morphological characterization, and corrosion product analysis. Furthermore, we optimized the 3D printing parameters of the bio-adhesive coating, enabling its application in corrosion protection under special environment. This study provides a novel approach for the development of environmentally friendly, renewable, and cost-effective corrosion protection technologies based on living microbes.

Keywords: 3D printing, living microbial coating, corrosion protection, bioink

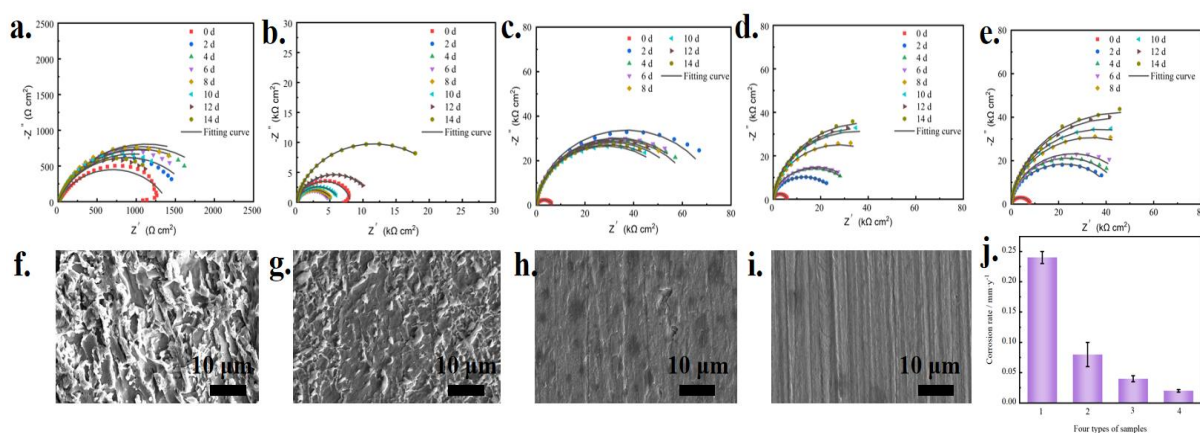


Fig. 1 Corrosion protection of living microbial coating. (a-e) Nyquist plots X80 pipeline steel during the 14-d immersion in artificial seawater solution with (a) no coating, (b) only hydrogel, (c) only *Vibrio natriegens*, (d) living coating with microbes embedded in hydrogel, and (e) 3D printing hydrogel loaded with microorganisms; (f~g) corrosion morphology of X80 pipeline steel immersed in artificial seawater for 14 days under conditions same to Fig. a-d; (j) weight loss analysis of X80 pipeline steel after 14-d immersion under conditions same to Fig. a-d.