Near-Infrared Persistent Phosphors with Ultraviolet Shielding as Smart Sensors for the Nondestructive Imaging of Corrosion Onset in Coated Magnesium Alloys

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Magnesium alloys are promising engineering materials owing to their excellent mechanical properties and relatively low density. However, they possess poor corrosion resistance, limiting their applications. Detecting and imaging corrosion onset in coated magnesium alloys is crucial for preventing large-scale corrosion. However, imaging corrosion location and degree of corrosion poses significant challenges. Herein, a novel fluorescent sensor for imaging corrosion onset in magnesium alloys is synthesized by coating ZnO (ultraviolet-shielding shell, ZO) on $ZnGa_2O_4:Cr^{3+}$ (near-infrared (NIR) signal source, ZGOC). The NIR emission and afterglow of ZGOC disappear after coating with ZnO. Because the alkaline environment formed following the corrosion of magnesium alloys can dissolve the ZnO shell, the NIR afterglow signal arising from ZGOC@ZO can accurately determine the location and degree of the corrosion. This nondestructive imaging technology using NIR-based ZGOC@ZO sensor demonstrates similar accuracy to that obtained through scanning electron microscopy and electrochemical impedance spectroscopy for the early corrosion detection of coated magnesium alloy. Moreover, this technology can detect corrosion onset earlier than the laser confocal testing technology as well as locate and image the degree of corrosion of magnesium alloy. This work demonstrates the detection of corrosion onset in magnesium alloys, which can be extended to other metals.

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