Eu-MOF/Epoxy Multifunctional Nanocomposites with Excellent Anti-Corrosion, Fluorescent Corrosion Monitoring, and Flame-Retardant Properties

Kun-Ling Teng[1], Yun-Yun Yan[1], Yuan-Hsiang Yu*[1]
[1*]Department of Chemistry, Fu Jen Catholic University, New Taipei City, Taiwan
(084916@mail.fju.edu.tw)

INTRODUCTION

Epoxy resins are widely used in anti-corrosion coatings due to their excellent mechanical strength, adhesion, and chemical resistance. Incorporating nanofillers or functional additives into the epoxy matrix enhances barrier properties by extending the diffusion path of corrosive agents and improving overall durability. The hydrogenated epoxy resin HDGEBA (abbreviation as HEP) further offers superior UV resistance and aging stability compared to conventional DGEBA.[1] Metal-Organic Frameworks (MOFs), with their tunable porosity and high surface area, have emerged as effective nanofillers that can significantly enhance the corrosion resistance and overall performance of epoxy coatings.[2–4] In this study, novel fluorescent Eu-MOF/HEP epoxy nanocomposites were developed. The incorporation of Eu-MOFs not only significantly improved corrosion resistance and flame retardancy through their porous structure but also enabled real-time fluorescence-based detection of corroded sites. The results demonstrate a smart, multifunctional coating with enhanced durability, corrosion protection, flame retardancy, and visual monitoring capabilities.

RESULTS AND DISCUSSION

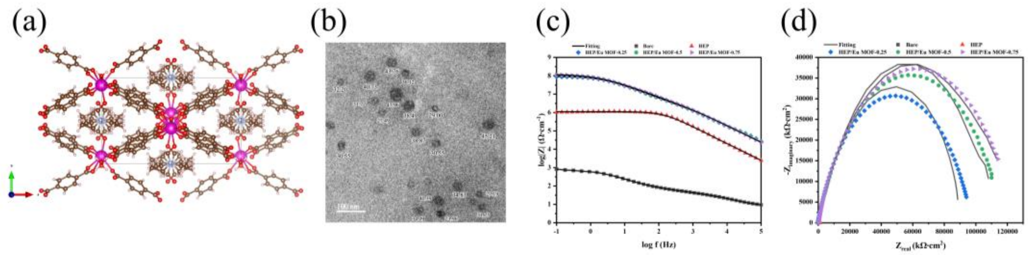

Fig. 1. (a) X-ray crystal structure of the Eu-MOF; (b) TEM image of Eu-MOF-0.75/HEP nanocomposite; (c) Bode plots of the composite coatings; (d) Nyquist plots of the composite coatings.

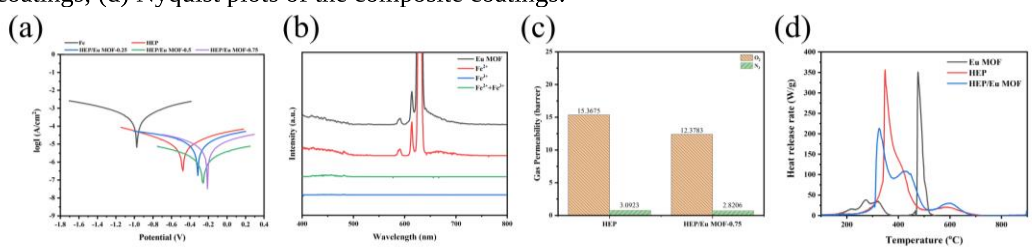

Fig. 2 (a) Tafel plots of the composite coatings, (b) Eu-MOF fluorescence quenching by Fe^{3+} ion, (c) Gas permeation of Eu-MOF-0.75/HEP nanocomposite and HEP, (d) Comparison the peak heat release rate of Eu-MOF, HEP, and nanocomposite.

CONCLUSION

Eu-MOF and epoxy resin show excellent compatibility, forming high-performance nanocomposites. X-ray crystallography confirmed the structure of Eu-MOF, while TEM analysis revealed Eu-MOF nanosized and well-dispersed in the polymer matrix. The Fe^{3+} ions arise from corrosion could quench the fluorescence of Eu-MOF, enabling corroded sites detection. The porous MOFs act as physical barriers and significantly reduce the peak heat release rate (pHRR) by 34.1%. The HEP/Eu MOF-0.75 nanocomposite achieves optimal anticorrosion efficiency, flame retardancy, and multifunctionality through enhanced dispersion.

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