

## **Anisotropic corrosion behavior of laser-based direct energy deposited H13 steel in molten ADC12 aluminum alloy**

**Guo Wang**<sup>1</sup>, Weidong Lou<sup>1</sup>, Chaoyang Deng<sup>2</sup>, Wenyu Ma<sup>2</sup>, Haidong Zhao<sup>1\*</sup>

<sup>1</sup> *National Engineering Research Center of Near-Net-Shape Forming for Metallic Material, South China University of Technology, Guangzhou 510640, China*

<sup>2</sup> *Institute of New Materials, Guangdong Academy of Sciences, Guangzhou 510650, China*

[1569237039@qq.com](mailto:1569237039@qq.com)

**Abstract** Immersion corrosion experiment for laser-based direct energy deposited H13 steel in ADC12 aluminum alloy melt was investigated based on the evaluation demands for the corrosion resistance after mold repair. The effect of the anisotropic microstructure of the deposited H13 steel on the corrosion behavior was explicated by characterizing the microstructure of the deposited H13 steel before and after corrosion. The results show that the microstructural heterogeneity affects the initiation, development and stabilization process of corrosion. Corrosion is prone to initiate near the heat affected zone due to the heterogeneous distribution of grain size, carbide, and dislocation density. Planes with weak microstructural heterogeneity are less prone to develop cracks in the intermetallic compounds (IMCs) layer during the corrosion development stage thus exhibiting a slower corrosion rate. Its IMCs layer stabilizes faster during the corrosion stabilization stage. The plane perpendicular to the build direction has the highest corrosion resistance for fewer corrosion initiation locations and the weakest microstructural heterogeneity. In addition, the composite structure of carbide core + Si phase shell generated during the corrosion contributes to improve the localized corrosion resistance. This study provides insights into understanding the influence of the additive manufacturing heterogeneous microstructure on the reaction-diffusion process, as well as offers guidance on direction selection when preparing components for application in contact with aluminum melts via additive manufacturing techniques.

**Keywords** H13 steel; Direct energy deposition (DED); Molten aluminum corrosion; Microstructural heterogeneity; Corrosion anisotropy.

### **Reference**

---

[1] Xu G, Wang K, Dong X, Yang L, Ebrahimi M, Jiang H, et al. Review on corrosion resistance of mild steels in liquid aluminum. J Mater Sci Technol 2021;71:12–22. <https://doi.org/10.1016/j.jmst.2020.08.052>.