

Synergistic effects of Ti and Al additions on the mechanical properties and corrosion behavior of FeCrNi medium entropy alloy fabricated by selective laser melting

Xi Bai^{1, 2}, Zhiheng Zhang³, Jianqiu Wang^{2, 3}, Lei Wang¹, Enhou Han³

¹ Key Laboratory for Anisotropy and Texture of Materials (Ministry of Education), School of Materials Science and Engineering, Northeastern University, Shenyang 110819, China

² CAS Key Laboratory of Nuclear Materials and Safety Assessment, Institute of Metal Research, Chinese Academy of Sciences (CAS), Shenyang 110016, China

³ Institute of Corrosion Science and Technology, Guangzhou 510530, China

xbai22h@imr.ac.cn

Abstract Medium entropy alloys (MEAs) or high entropy alloys (HEAs) containing multiple elements have attracted significant attention, particularly strengthened MEAs with the addition of Ti and Al [1-3]. Among the different processing methods, there has been growing interest in the development of alloys fabricated through selective laser melting (SLM) [4, 5]. Despite the promising application potential of HEAs produced through additive manufacturing techniques, there remains limited understanding regarding their passive behavior exhibited by various HEAs manufactured using SLM as well as corrosion resistance. Therefore, the corrosion behavior of the SLM-fabricated FeCrNi and (FeCrNi)₉₄Al₃Ti₃ (molar ratio) MEAs was investigated in this work. With the addition of alloying elements Ti and Al, the structure of the FeCrNi MEA changes from single FCC structure to FCC + BCC dual-phase structure. The addition of Ti and Al in FeCrNi MEA results in a remarkable increase in the yield strength, which rises from 536 MPa to 948 MPa. Consequently, the SLM-fabricated dual-phase (FeCrNi)₉₄Al₃Ti₃ MEA exhibits excellent mechanical properties compared to the single-phase FeCrNi MEA. Subsequently, potentiodynamic polarization and electrochemical impedance spectroscopy were employed to investigate corrosion behavior and resistance in different environments, such as NaCl and H₂SO₄. The potentiodynamic polarization curves in 3.5 wt% NaCl solution and 0.05M H₂SO₄ solution at room temperature reveal that corrosion resistance of (FeCrNi)₉₄Al₃Ti₃ MEA are comparable to those observed for FeCrNi MEA. The addition of Ti and Al provides obvious strength increment and maintain acceptable corrosion resistance, demonstrating a strong trade-off between corrosion resistance and mechanical properties. The work is crucial as it provides valuable insights into the corrosion resistance of SLM-fabricated MEAs.

Keywords medium entropy alloys; selective laser melting; mechanical properties; corrosion behavior.

Reference

- [1] J.W. Yeh, S.K. Chen, S.J. Lin, et al., *Adv. Eng. Mater.* 6(5) (2004) 299-303.
- [2] B. Cantor, I.T.H. Chang, P. Knight, et al., *Mater. Sci. Eng. A* 375-377 (2004) 213-218.
- [3] Y.L. Zhao, T. Yang, Y. Tong, et al., *Acta Mater.* 138 (2017) 72-82.
- [4] J.Y. Lee, J. An, C.K. Chua, *Appl. Mater. Today* 7 (2017) 120-133.
- [5] C. Han, Q. Fang, Y. Shi, et al., *Adv. Mater.* 32 (26) (2020) 1903855.