J Adv Manuf Eng, Vol. 5, Issue. 1, pp. 9–14, March, 2024

Journal of Advances in Manufacturing Engineering
Web page info: https://jame.yildiz.edu.tr
DOI: 10.14744/ytu.jame.2024.00002

Original Article

Corrosion inhibition of AlSi10Mg additively manufactured parts in 3.5% NaCl solution

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ARTICLE INFO

Article history
Received: 10 January 2024
Accepted: 25 March 2024

Key words:
AlSi10Mg, corrosion, laser powder bed fusion (LPBF), inhibition.

ABSTRACT

In this study, corrosion inhibition of the additively manufactured AlSi10Mg was investigated in 3.5% NaCl solution with the addition of 1% and 3% NH_4NO_3. The potentiodynamic polarization and electrochemical impedance spectroscopy tests were performed in order to reveal the corrosion behavior of the AlSi10Mg. The corrosion inhibition behavior of the AlSi10Mg was determined by analyzing the Tafel curves, phase angle/frequency curves and equivalent circuit results. Moreover, microstructures of the produced sample and corroded surfaces were investigated with light metal microscopy. It was stated that the corrosion rate value of the AlSi10Mg is reduced with the presence of NO_3^- in 3.5% NaCl solution. On the other hand, the surface/solution interaction was reduced by adding NH_4NO_3 into 3.5% NaCl solution. It can be clearly emphasized that using 3% NH_4NO_3 is quite effective in improving the corrosion behavior of AlSi10Mg in 3.5% NaCl.

Cite this article as: Özbay Kısasöz, B. (2024). Corrosion inhibition of AlSi10Mg additively manufactured parts in 3.5% NaCl solution. *J Adv Manuf Eng*, 5(1), 9–14.

INTRODUCTION

Additive manufacturing (AM) is a promising manufacturing process to produce metallic parts with desired properties. Laser powder bed fusion (LPBF) is one of the AM methods, and metallic powders are deposited layer-by-layer with a laser beam [1–3].

AlSi10Mg alloy has often been used in the conventional casting process. The chemical composition of the alloy is near eutectic, and AlSi10Mg has lower shrinkage and higher fluidity owing to its chemical composition. Besides, AlSi10Mg is also of interest for additive manufacturing processes, and AlSi10Mg has been widely used in LPBF process [4–7].

The LPBF AlSi10Mg parts exhibit higher mechanical properties compared to conventional cast parts. Manfredi et al. [8] stated that LPBF AlSi10Mg parts have higher yield strength and hardness values compared to conventional A360 alloy. It was revealed that the LPBF process provides the fine distribution of silicon and grain refinement due to the rapid cooling of the structure [9, 10]. Moreover, besides mechanical properties, the LPBF AlSi10Mg's corrosion properties are also crucial. It has been observed that the corrosion resistance of aluminium alloys produced by AM processes is equal to or slightly higher than conventional casting techniques [11–13]. Chen et al. [14] determined that the LPBF process improves the corrosion resistance of Al-12Si alloy in 3.5% NaCl, compared to the as-cast condition.

On the other hand, various have been carried out to improve the corrosion resistance of the LPBF AlSi10Mg. Surface treatments, like chemical etching, sand blasting and shot peening are applied to LPBF alloy to obtain higher corrosion resistance [15–18]. It was also reported that the usage of corrosion inhibitors can slow down the corrosion reactions and reduce corrosion damage in the AlSi10Mg parts [19–22].

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