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PROCEEDINGS

Microstructure Refinement for Superior Ductility of Al–Si Alloy by Electron Beam Melting Additive Manufacturing

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ABSTRACT

Refining the Si phase in Al–Si alloy has been a research interest for decades. Previous studies suggested many Al- and Si-enriched nano-segments (approximately 100 nm) can coexist in a melted Al–Si liquid solution when they were reheated to a temperature between 1080 and 1290 °C. These nano-segments could be retained to become crystal nuclei and grew into fine grains under a very fast cooling rate. Thus, this provides a novel approach of refining the microstructure of Al–Si alloy using electron beam melting (EBM) technology because the temperature exceeds 1500 °C in the melting pool with a cooling rate higher than 103 °C/s during EBM building process. In this study, EBM is used to refine the microstructure of AlSi10Mg alloy to enhance the ductility. The formation mechanism of the microstructure during EBM build process was discussed.

An argon gas-atomized AlSi10Mg (wt%) powder was used to fabricate as-built specimens using an Arcam A2X EBM system (Arcam AB, Mölndal, Sweden). AlSi10Mg alloys with well surface finish were fabricated using EBM. The microstructure observation shows mixed fine island-like and scattered granular Si phase particles (approximately 2 μm) having rounded corners and edges were embedded in the Al matrix. Fine Al sub-grains with size of 0.5–2 μm formed during EBM building process. A maximum ductility of approximately 32.7% with a tensile strength of approximately 136 MPa were achieved for the as-EBM-built AlSi10Mg alloy. The improved ductility compared with cast ones was attributed to the fine Si phase and the bimodal Al grains (large and fine sub-grains). A novel pathway of refining the Al–Si alloy microstructure to improve the tensile ductility without adding any modification element was developed in this study.

KEYWORDS

EBM; additive manufacturing; Al-Si alloy; microstructure

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