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Microstructural evolution in electron beam additive manufactured Ti–6Al–4V build plate: Thermal modeling and microstructural characterization

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ABSTRACT

Electron beam additive manufacturing (EBAM), which aims to fabricate net or near net shaped components in successive layers, has become an increasingly important manufacturing technology. It is particularly appealing for titanium alloys because it provides an effective alternative solution for the processing of titanium components, especially for the large parts. However, the microstructure, which significantly affects the mechanical properties of the component, is quite complex in EBAM due to the process thermal cycling and has not been fully understood yet. In this study, the macro- and microstructure of the single pass, six-layer Ti–6Al–4V build plate was examined. A 3D finite element model has been built to acquire the thermal history and thereby understand the microstructural evolution in EBAM Ti–6Al–4V build plates. The simulated macrostructure characterization was compared with the actual sample. The good agreement indicates the resolution of the model is sufficient to correctly predict the depth of the molten pool for each deposited layer and the macrostructure of the whole build plate. The thermal histories obtained from thermal modeling were physically simulated using Gleeble® 3500 and the resulting microstructures were compared with the EBAM build plate to further validate the model. Since the thermal history is sensitive to the process parameters, knowing how thermal history affects the resultant microstructure creates an opportunity to control the microstructure of EBAM components with optimized process parameters.

KEYWORDS: additive manufacture, electron beam, Ti–6Al–4V, microstructure evolution, modeling