MANUFACTURING ENGINEERING

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PhD Doctoral Proposal

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Machine Learning for Smart Post Processing of Additively Manufactured Ti-6Al-4V Parts

Abstract

Additive manufacturing (AM) is the emerging manufacturing technology that fabricates the near-net shape components directly from CAD data files in a layer-by-layer fashion. Titanium and its alloys have been widely used in military applications, aircraft, spacecraft, sports equipment, automobile, and medical devices due to their chemical inertness, biocompatibility, high strength-to-weight ratio, desirable mechanical properties, and good corrosion resistance. Targeted to relieve the residual stress, reduce the porosity, modify the microstructure and achieve isotropic mechanical properties, heat treatment is strongly recommended for as fabricated AM Ti-6Al-4V components. It is needed to establish a comprehensive understanding of heat treatment on AM Ti-6Al-4V parts.

This proposal proposes to employ machine learning to develop a computational model that can establish the correlations among heat treatment parameters of AM Ti-6Al-4V alloy parts and resulting microstructures and mechanical properties. The innovation of this proposal is the development of a data-driven model that is based on existing success and understanding of wrought Ti-6Al-4V but will be further trained by newly generated data on heat-treated additively manufactured Ti-6Al-4V parts. This innovation takes advantage of powerful data-driven machine learning to generate smart guidance and predication for efficient post-process heat treatment that effectively manipulates the microstructure and results in desirable properties of additively manufactured Ti-6Al-4V parts.

This project will use the modeling developed in heat treatment of wrought Ti-6Al-4V alloy as the starting point. By using the neural network based machine learning approach, we will further train and modify the modeling parameters by feeding the model with newly generated data on additively manufactured Ti-6Al-4V parts to predict the process-microstructure-properties relationship in this new class of Ti-6Al-4V components. Finally, we will link this model with existing models by ICME (Integrated Computational Materials Engineering) approach which is widely used to design products.