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The Applications of Aritificial Intelligence to the Predictions of Processing-Microstructure-Property Relationships

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Abstract : the report high-throughput, ultra-fast laser sintering of alumina sample array and characterization of sample units' microstructure and hardness, as a fast exploration of laser processing parameters, microstructure, and property. These experimental data were used to train machine-learning (ML) models. Accurate ML predictions were demonstrated for the processing-microstructure-property relationship, specifically in (1) prediction of the microstructure of alumina under arbitrary laser power and (2) prediction of the expected microstructure from the desired hardness. An independent neural network was developed and showed that ML-predicted microstructure had less than 10% error from real ones, in terms of projected hardness. To monitor the microstructure during laser sintering, we demonstrated an ML model that can instantaneously predict ceramic's microstructure at the laser spot, based on the laser spot brightness. The ML model can generate more than 10 predictions per second, and the error in average grain size was less than 5% from the experimental observations.

Keywords : machine learning, additive manufacturing, ceramics, microstructure, hardness
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