Nanotomography characterization and phase identification of high temperature 3D printed Al-Ce alloys

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The interfacial area between phases, where nucleation occurs, plays a crucial role in solid state phase transformations. Additionally, the stability of secondary phases will influence the mechanical properties and decisions regarding material heat treatment. However, the interfacial energy is difficult to determine, especially in complex systems such as the ternary Al-Ce-Mn alloy. To model the phase transformation that occurs when additively manufactured Al-2.2Ce-4.3Mn (at%) decomposes during heat treatment, an accurate representation of the as-fabricated microstructure must be obtained. Using 2D images (SEM) of the microstructure to approximate the 3D geometry can result in incorrect calculation of the interfacial energy, an important parameter in models used to predict the nucleation rate. In this work, 3D nanotomography in a FIB-SEM is used to sequentially mill and image the microstructure of additively manufactured Al-Ce-Mn. Deep learning, with a U-Net architecture, is then used to segment the heterogenous microstructure morphology to quantify the difference in the interfacial volume between the intermetallic and the matrix in each solidification region. This approach of accurately defining the initial state of the alloy before decomposition reduces the assumptions about the interfacial geometry used to calculate the interfacial energy and predict interface coherence