15th International Congress for Stereology and Image Analysis
Aarhus University, 27–30 May, 2019

Abstract

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Extraction of poorly visible grain boundaries from tomographic image data, using convolutional neural networks

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The investigation of the morphology of grain boundaries in polycrystalline materials is of interest in the field of materials science. Sophisticated measurement techniques, like 3D X-ray diffraction (3DXRD), can determine crystallographic orientations of grains and thus provide the location of grain boundaries. However, such methods are expensive, time consuming and difficult to perform in situ, e.g., during thermodynamic treatment. More available techniques, such as X-ray microtomography, often provide challenging data when imaging alloys, since grain boundaries do not induce contrast in computed tomography (CT) image data. This work deals with image data of an aluminum-copper specimen in which a liquid attaches to grain boundaries during Ostwald ripening. Since the contrast between grain interior and boundaries can be poor in CT data for low amounts of liquid, it is difficult to extract the grain boundaries from CT data with conventional image processing techniques. Therefore, a convolutional neural network was trained with matching pairs of CT and 3DXRD data to detect poorly visible grain boundaries solely from CT data. The network's output was then segmented into grains with conventional image processing techniques like the watershed transform. This approach leads to a sufficiently good segmentation of grains in CT data such that quantitative analysis and stochastic modeling of the grain microstructure are possible.