Enhanced understanding of the reconstructed austenite microstructure with EBSD

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Abstract

Thermomechanical processing is widely used to control the microstructure and final properties of high strength low alloy steels. In these processing routes, the high temperature parent austenite microstructure strongly influences the final material properties, but this high temperature phase is difficult to observe directly and indirect reconstruction from EBSD can be used due to the orientation relationship (OR) between the phases (e.g. Kurdjumov-Sachs OR). There are now many examples where the reconstruction of the parent microstructure has been used to understand the final microstructure from 2D EBSD. In this work we extend beyond current approaches using large area and fast EBSD combined with pattern matching to recover high spatial resolution maps across large areas (e.g. 1 mmˆ2, with 240 nm step size) from HSLA steels that include successfully indexed retained austenite islands (1-2 μm in diameter). The parent austenite grain structure is reconstructed from the ferrite phase EBSD data using grain reconstruction methods in MTEX (including Nyyssönen et al. 2016). Our data analysis pipeline enables validation of the reconstruction algorithm and determination key parameters to recover the parent structure well, as well as understanding which regions may be incorrect. Furthermore, we build on this 2D analysis pipeline by extending this analysis to 3D using a plasma FIB instrument coupled with EBSD. To achieve this, we have developed a new algorithm that carefully links the data for each slice to build up the 3D microstructure, and labels together the child and parent phases for each voxel. In addition to increasing fidelity of the reconstruction, as more interlocking variants can be used to understand the 3D microstructure, it also allows for further analysis of the true 3D size and morphology of the grains.

Keywords: Microstructure, 3D, Parent grain reconstruction, EBSD, orientation relationship

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