
Statistical analysis of micro-deformation mechanisms of HCP zinc coatings by in-situ SEM-DIC aligned to EBSD

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Abstract

HCP plasticity is complex due to the high anisotropy, apparent brittleness, and the alternative plasticity mechanisms that often activate, such as twinning, grain boundary sliding, and/or grain boundary migration, alongside plasticity of multiple active HCP crystallographic slip families. Detailed understanding of HCP plasticity is important for many applications, such as zinc corrosion coatings for steel. In this study, a range of novel methodologies for high-resolution and robust measurement and identification of micromechanical deformation mechanisms are applied to identify all the different plastic mechanisms. The methodologies are based on *in-situ* EBSD-SEM-DIC testing, capable of obtaining strain fields with a ~ 40 nm spatial resolution aligned to EBSD microstructure maps (1,2), with recently developed advanced EBSD-SEM-DIC analysis routines to quantify all HCP slip system activity maps as well as the activity maps of twinning, grain boundary sliding, and grain boundary migration (3,4). A detailed statistical analysis has been conducted of these different plasticity mechanisms and their mutual interactions in zinc coatings, including > 300 grains, corresponding to a total grain boundary length of ~ 2.9 mm. This huge statistical analysis resulted in a detailed hypothesis that tries to explain the activation of the 4 active zinc slip families, the occurrence of twinning, and the statistical analysis between the various identified GB properties of each GB segment, including the identified in-plane sliding and/or apparent opening kinematics, its angle with the loading direction, the crystallographic misorientation angle. Additionally, the interaction between these plasticity mechanisms has been studied, as will be presented at ESMC in Lyon.

References

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