A multi-scale study of the interaction of Sn solutes with dislocations during static recovery in α-Fe - DTU Orbit (17/09/2019)

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The properties of engineering materials can be improved by optimising the microstructural developments during annealing processes. Here, we investigate the effect of Sn on the recovery annealing of cold rolled Fe–3%Si alloys. We use a multiscale approach combining micro hardness, electron back scattering diffraction (EBSD), and dark field X-ray microscopy (DFXM): a recent, non-destructive synchrotron-based technique that allows 3D mapping of orientation and lattice strain within individual grains embedded in bulk samples. Micro hardness results show that the Sn solute has a strong effect on the recovery kinetics. These results are compared to a physical kinetic model suggesting that Sn limits the softening. This observation is further discussed by a complementary atomistic modelling that demonstrates solute-dislocation interaction around edge dislocations. In situ DFXM experiments reveal the 3D microstructural evolution upon annealing at the grain level with high angular resolution. The DFXM observations show that Sn slows the recovery kinetics within individual grains, in agreement with the other microscopic investigations. Furthermore, the DFXM results provide a direct observation of strain fields around dislocation loops in an embedded single grain, which is argued to remain static due to solute effect during recovery.

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Corresponding author: Yildirim, C.
Contributors: Mavrikakis, N., Detlefs, C., Cook, P. K., Kutsal, M., Campos, A. P. C., Gauvin, M., Calvillo, P. R., Saikaly, W., Hubert, R., Poulsen, H. F., Vaugeois, A., Zapolosky, H., Mangelinck, D., Dumont, M., Yildirim, C.
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