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Intragranular orientation spread induced by grain interaction

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Data on plastic deformation of metals monitored in-situ by three-dimensional X-ray diffraction microscopy (3DXRD) reveal that initially similarly oriented grains behave differently. The present focus is on two grains of near $\langle 522 \rangle$ orientation in the bulk of an interstitial-free steel subjected to 9% tensile deformation. The centre-of-mass orientations of the two grains neither rotate in the same direction nor with the same rate, and both develop internal orientation spreads of the order of 4 degrees. These differences originate from variations in the relative activities of the two most stressed slip systems, which are attributed to grain interaction effects. A spatially resolved map of the local environment of neighbouring grains as well as the orientation gradients within each grain has been reconstructed from the 3DXRD data. The grain interaction mechanisms are elucidated by crystal plasticity modelling based on the measured grain orientations and grain boundary planes.