Response of oxide nanoparticles in an oxide dispersion strengthened steel to dynamic plastic deformation - DTU Orbit (19/12/2018)

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The behavior of oxide nanoparticles in an oxide dispersion strengthened (ODS) steel subjected to dynamic plastic deformation (DPD) was investigated by transmission electron microscopy (TEM) and high resolution TEM (HRTEM). Contrary to the motivation for dispersing oxides in a ferritic matrix that the hard particles would be non-deformable and constitute obstacles of plastic deformation, it is discovered that oxide nanoparticles with sizes smaller than 20 nm were appreciably deformed to an average equivalent strain of 1.2 in the sample after DPD to a strain of 2.1. The plastic distortion of the oxide nanoparticles by compression increases with the externally applied strain. HRTEM analysis demonstrates that deformation twinning is the dominant mechanism of plastic deformation for the oxide nanoparticles. In addition, experimental results show that the deformation of oxide nanoparticles does not only occur at high strain rates, but also at lower strain rates, and does not rely on the interfacial coherency between the oxide nanoparticle and the ferritic steel matrix. Due to the incompatible deformation between the oxide nanoparticles and matrix, nanoscale voids form at their interface during deformation at low strains, and evolve with increasing deformation in distinctively different manner around larger and smaller particles. The reasons for the size effect on the deformation of oxide nanoparticles and on the co-deformation between oxide nanoparticles and ferritic matrix in the ODS steel are discussed.

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