

SUPPRESSING DAMAGE IN DUAL PHASE STEEL: INSIGHTS FROM MICROMECHANICS

Chunhua Tian, Max-Planck-Institut für Eisenforschung GmbH, D-40237 Düsseldorf, Germany
c.tian@mpie.de

Christoph Kirchlechner, Max-Planck-Institut für Eisenforschung GmbH, D-40237 Düsseldorf, Germany

Key Words: BCC ferrite, slip planes, damage nucleation.

Single crystalline ferrite and martensite islands were extracted from two different dual phase (DP) steel grades by focused ion beam milling (FIB) and tested by in situ pillar compression. Three slip plane families {110}, {112}, {123} in bcc ferrite are all observed to be active and their corresponding mean critical resolved shear stress (CRSS) of 3 μ m pillars are found to be nearly identical, i.e. 147 ± 6 , 143 ± 9 , 146 ± 4 MPa. Non Schmid contributions either due to tension-compression anisotropy or a size dependent breakdown of Schmid's law plays a minor role in our case. Martensite pillars contain several interfaces which makes them deform isotropically and without distinct slip traces. The pillars exhibit a high mean compressive yield strength up to 2880 ± 49 MPa and a low scatter of 188 ± 17 MPa. By comparing two DP steels possessing identical ultimate tensile strength, the sample with softer ferrite phase and a harder martensite yields at a lower stress and shows a larger fracture elongation. The post mortem investigation of the macroscopic sample indicates that a larger mechanical heterogeneity between ferrite and martensite increases the amount of crack initiation sites but the improved local strain hardening capability imposed by a softer ferrite matrix suppresses catastrophic failure considerably.

We thank Gerhard Dehm (MPIE) for discussions and the DFG for financial support via TRR188 project.