A novel type of yield strength anomaly in a CoNi-base superalloy

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The present work aims to clarify the reasons of a novel type of yield strength anomaly (YSA) in a multicomponent CoNi-base superalloy (ERBOCo-4), which leads to an anomalous increase of the yield strength with increasing temperature and/or decreasing strain-rate. Conventional transmission electron microscopy investigations reveal that the YSA is associated with a transition from precipitate shearing by APB-coupled dislocation pairs to shearing by stacking fault formation. Atomic-scale structural and chemical investigations on interfacial dislocations are used to rationalize the observed transition. By quantifying the segregation of individual elements, the propagation velocity of the leading Shockley partial dislocations of superlattice stacking faults is calculated and the effective strain-rate is determined. The anomalous yielding of this and other Co-base and CoNi-base superalloy is explained by a transition of the shearing mechanism induced by a segregation-assisted dissociation of interfacial dislocations, which inhibits other shearing mechanisms, in combination with a too low propagation velocity of the leading Shockley partial dislocations.

Keywords: Co-base superalloys; yielding behavior; transmissions electron microscopy; high temperature deformation; defect structures

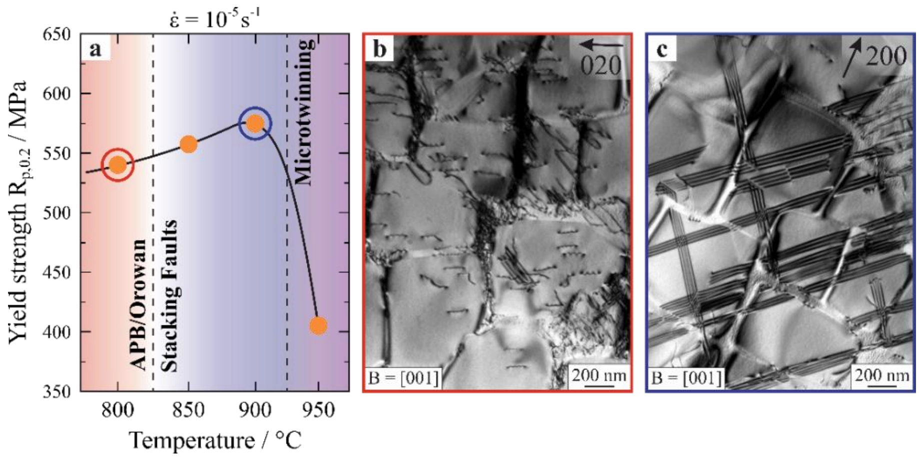

Fig.1: Anomalous yielding of the single-crystalline CoNi-base superalloy ERBOCo-4. (a) Increasing yield strength up to 900 °C at a strain-rate of 10^{-5} s^{-1}. (b,c) TEM micrographs revealing (b) numerous APB-coupled dislocation pairs at 800 °C and (c) a high stacking fault density at 900 °C.