The mechanical behavior of body-centered cubic (bcc) ultrafine-grained (UFG) materials processed by equal channel angular pressing (ECAP) has been investigated. Focus was on the characterization of fatigue properties of UFG bcc alloys in the low-cycle and high-cycle fatigue (LCF and HCF) regimes and under crack growth conditions. Under all loading conditions the role of microstructural characteristics on the damage evolution has been examined in detail.

In the LCF regime the UFG bcc alloys processed along so called efficient ECAP routes show superior fatigue properties. Cyclic stability is found to be due to high volume fractions of high angle grain boundaries and the impurity content. A heat treatment aiming at pure recovery of the microstructure is able to improve fatigue behavior. Additional factors influencing the fatigue response are mean stress and the homologous temperature. Crack initiation can be linked to elongated structures present in the UFG microstructure eventually leading to increased local stresses.

In the HCF regime UFG IF steel shows superior properties, i.e. an increased fatigue limit, due to increased monotonic strength, but at the same time notch sensitivity is pronounced. The crack growth behavior for the UFG conditions featuring the smallest grains is inferior. The crack follows elongated structures, which are in fact aligned parallel to the direction of material flow during ECAP.