ABSTRACT

The deformation behaviour and dislocation substructure of crystalline solids is attributed to the physical processes of dislocation passing obstacles. The energy needed to overcome an obstacle, i.e. an impurity, atom, etc. is provided by activated dislocation caused by either mechanical or thermally activated processes. To verify which deformation mechanism is active in low alloy steel, tensile tests interrupted by stress relaxation periods were studied. These tests were performed over temperatures ranging from 288K to 873K and at constant strain rate.

Strain rates before and after stopping the cross-head and deformation mechanisms were determined. The results of these experiments and how they correlate with the effects of temperature were also discussed. Rather than interpreting the difference to be due to mechanically activated deformation, as has been considered elsewhere, deformation was considered to be thermally activated with a component responsible for hardening and a component unaccompanied by hardening. Creep of low alloy ferrite steel is recovery controlled. Recovery in this material was caused by complex structures of carbides precipitates while dislocation tangles recovery was attributed both to carbide growth and to tangled dislocations re-arrangement and annihilation. Mechanical activation of dislocation glide has not been detected in these experiments.

Flow stresses were calculated from the strain rate differences together with the strains estimated to be due to the hardening component of deformation using a rate equation that describe thermally activated glide controlled deformation. Flow stress–strain curves that were plotted were found to be independent of testing temperature. These curves were compared to hardening curves determined previously from constant force creep tests and were found to be similar.