PARAMETER LINK AS AN APPROACH TO HIERARCHICAL MODELLING OF TOUGHNESS DECREASE OF STEELS

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Strengthening correlated with a decrease in ductility has been found in the recent past for the ferritic steel 15 NiCuMoNb 5 due to particle hardening by nanometer sized Cu-precipitates. Such precipitates exist because the Cu content lies above the solubility limit at ambient temperatures.

Several as cast as well as annealed material states were available for this steel. Information about the amount and sizes of the Cu-precipitates was obtained in a parallel study from small angle neutron scattering (SANS)-measurements.

The dislocation theory of Russel and Brown requires this information in order to calculate the hardening effect from a continuum mechanical based approach of particle strengthening for the system Fe-Cu. The particles are treated as shearable. Moreover, this theory assumes the same average distance and the same radius of the particles. The average particle radius is obtained from weighted averaging of the average particle sizes of precipitates already present in the material before annealing and from those additionally present after annealing.

By this approach it is possible to predict the experimentally measured strengthening level of different melts of the same material. These findings have been used to compare the damage mechanical behaviour of as-cast and annealed specimen. It is found that there exist worst cases with many very small precipitates which should be avoided.