Chapter V

Discussion

Effect of Austenitizing Condition on Softening Behaviour

In this experiment, after high temperature austenitizing at 1250 °C for 10 minutes a coarse austenite structure with a mean grain size of about 370 μm was achieved. A fine grain size of about 35 μm was achieved after austenitizing at 1000 °C for 5 minutes. The effect of the austenitizing conditions on softening mechanisms can be seen in figure 5-1. In case of a coarse austenite grain dynamic recrystallization does not seem to play important role when increasing strain rate. This may be due to the assumption that the rate of accumulation of dislocation density is low and the number of dislocation can be reduced by recovery. By this, dynamic recrystallization is retarded. Therefore the difference between maximum stress and steady state is small. This is different from a finer initial grain, where dynamic recrystallization is the main softening mechanism. This difference may be explained by the fact that a fine microstructure has more grain boundaries, which are a preferential place for nuclei of new grain compared to a coarse structure. The critical dislocation density to initiate dynamic recrystallization may be reached at lower strain

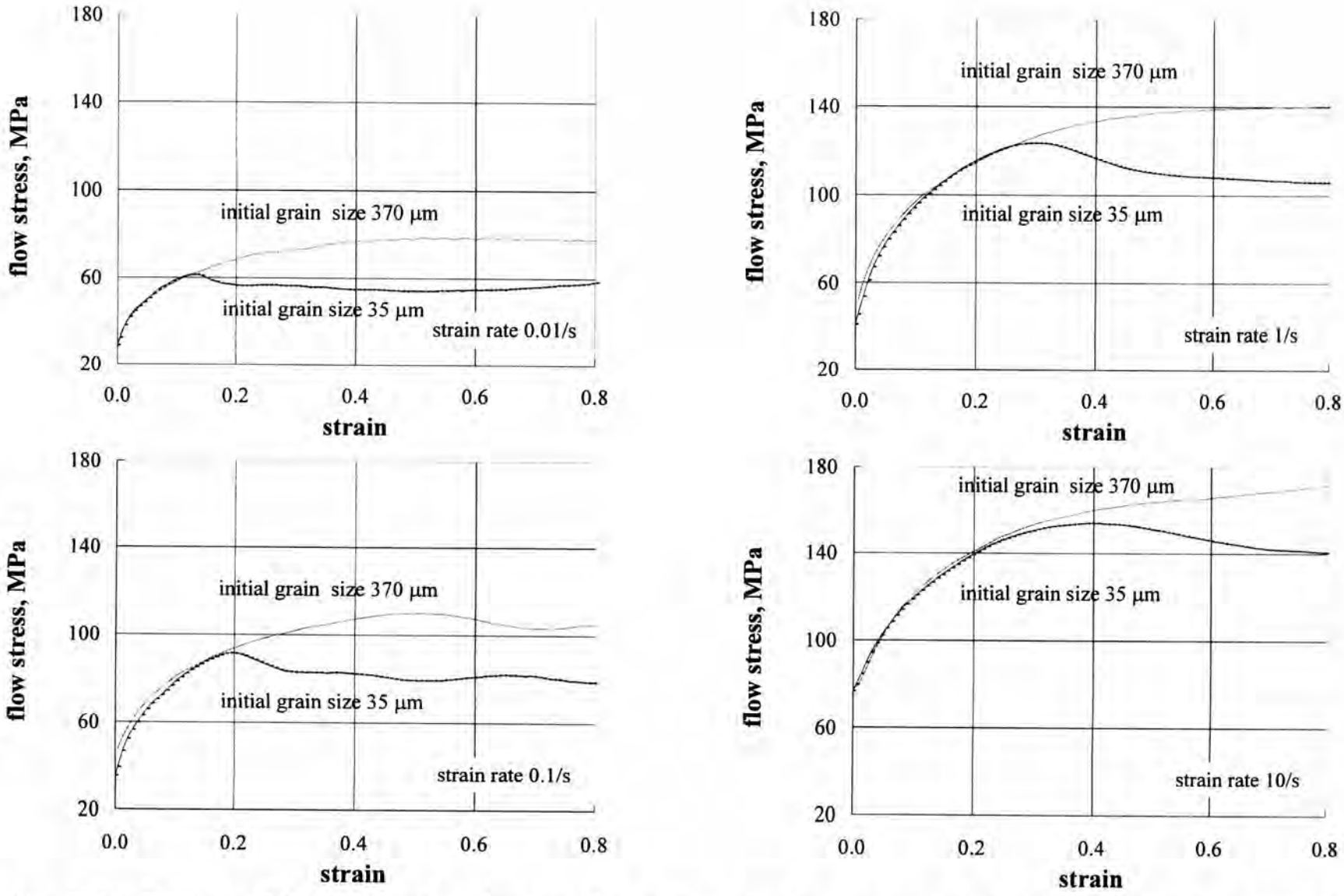

Fig. 5-1 : Effect of initial grain size on the stress-strain curves of St.15 at 950 °C (γ range)

values. In case of low temperature austenitization the AlN precipitates are less dissolved compared to that in case of high temperature austenitization. AlN precipitate is also a nucleation site for new grains, although it may lead to a retardation of dynamic softening processes by pinning the migration of grain boundaries. Therefore, in this investigation, dynamic recrystallization is case of austenitizing at 1000 °C occurs easier than that in case of austenitizing at 1250 °C.

Effect of Deformation Temperature on Stress-Strain Curves

Deformation temperature is a parameter which has an influence on the softening mechanism and the microstructure. For a deformation in the austenitic or ferritic range, decreasing deformation temperatures result in higher stress values. The ferrite grain size after deformation in the austenitic or ferritic range is decreasing with deformation temperature. For deformation in the austenitic range dynamic recrystallization is the main softening mechanism at low strain rate and high temperature, although the amount of dynamic recrystallization is a function of austenitizing condition, deformation temperature, strain and strain rate. When deformation was performed in the austenitic range, a uniform ferrite grain structure was resulted regardless of the strain rate. The grain size depends on deformation temperature. With decreasing deformation temperatures a finer grain size was achieved. For

deformation in the ferritic range recovery is the main softening mechanism, which does not seem to be affected by the process parameters, i.e., temperature and strain rate, although the stress values increase with decreasing temperatures. A strained microstructure was observed with a finer grain size for decreasing temperatures.

Effect of Strain Rate on Stress-Strain Curves

In figure 5-1, with increasing strain rates in the austenitic range, the strain at peak stress and the onset of the steady state stress are shifted to higher strains. Also the stresses are shifted to higher value. The difference between maximum stress and steady stress is reduced, which means that the amount of dynamic recrystallization is reduced. From that figure dynamic recrystallization of the austenite is completely suppressed in case of a coarse grain size at strain rates of 1 and 10/s. This is due to the fact that for higher strain rates the processing time is shorter, therefore a complete recrystallization may not be obtained. In figure 4-1 the effect of deformation temperature and strain rate on the critical flow stress is shown. With increasing strain rates the critical flow stress is shifted to higher levels.

In ferritic range the effect of strain rate on flow curves similar to that in austenitic range, whereby the steady state stress is shifted to higher value and lead to finer final grain size.