Studies related to the development and tensile deformation characterization of a titanium modified austenitic stainless steel referred to as Alloy D-9, to be used as a structural material in a fast breeder reactor forms the subject matter of this thesis. The alloy was first prepared and processed on a laboratory scale and then on an industrial scale. Accelerated ageing studies were carried out to find out the optimum level of cold work that would be stable against degradation in strength on exposure to the elevated service temperatures. The influence of the Ti/C ratio, cold work and strain rate on the tensile properties of the alloy was investigated over a wide range of temperatures. At most of the test conditions the tensile deformation of the alloy was governed by dynamic strain ageing (DSA), while at large strains, slow strain rates and high temperatures recovery processes played a dominant role. A detailed analysis of the various parameters, such as the critical strain for the onset of serrated flow, the load drop etc. related to DSA were carried out. The mechanisms responsible for DSA at different regimes of test conditions and the role of Ti on DSA were established based on this study. The tensile test data were further analyzed to find the most suitable semi-empirical relation to describe the flow and the work hardening behaviour. The strain rate sensitivity (SRS) of the flow stress was evaluated both as a macroscopic parameter (from monotonic tensile tests) and an iso-structural parameter (from strain rate jump tests). Both these SRS were found to be parameters that were sensitive to the occurrence of DSA or recovery processes. Flow transients were observed on a change of strain rate and these were found to be related to the strong solute-dislocation interactions. These interactions were also investigated through static ageing studies at room temperature. The thesis is presented in four parts and contains nine chapters.