

Effect of Different Thermomechanical Cycles on Microstructure of AISI 4140 Steel

Authors : L.L. Costa, A. M. G. Brito, S. Khan, L. Schaeffer

Abstract : Microstructure resulting from the forging process is studied as a function of variables such as temperature, deformation, austenite grain size and cooling rate. The purpose of this work is to study the thermomechanical behavior of DIN 42CrMo4 (AISI 4140) steel maintained at the temperatures of 900°, 1000°, 1100° and 1200°C for the austenization times of 22, 66 and 200 minutes each and subsequently forged. These samples were quenched in water in order to study the austenite grain and to investigate the microstructure instead of quenching the annealed samples after forging they were cooled down naturally in the air. The morphologies and properties of the materials such as hardness; prepared by these two different routes have been compared. In addition to the forging experiments, the numerical simulation using the finite element model (FEM), microhardness profiles and metallography images have been presented. Forging force vs position curves has been compared with metallographic results for each annealing condition. The microstructural phenomena resulting from the hot conformation proved that longer austenization time and higher temperature decrease the forging force in the curves. The complete recrystallization phenomenon (static, dynamic and meta dynamic) was observed at the highest temperature and longest time i.e., the samples austenized for 200 minutes at 1200°C. However, higher hardness of the quenched samples was obtained when the temperature was 900°C for 66 minutes. The phases observed in naturally cooled samples were exclusively ferrite and perlite, but the continuous cooling diagram indicates the presence of austenite and bainite. The morphology of the phases of naturally cooled samples has shown that the phase arrangement and the previous austenitic grain size are the reasons to high hardness in obtained samples when temperature were 900°C and 1100°C austenization times of 22 and 66 minutes, respectively.

Keywords : austenization time, thermomechanical effects, forging process, steel AISI 4140

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