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MICROMECHANICAL MODELING OF DUAL-PHASE DP600 STEEL SHEET PLASTIC BEHAVIOR BASED ON A REPRESENTATIVE VOLUME ELEMENT DEFINED FROM THE REAL MICROSTRUCTURE

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Dual phase steels offer very attractive combinations of strength and ductility owing to the coexistence of different microstructures components and their interactions. These properties made these steels very suitable to the automotive industry due to improved impact resistance increasing the passenger safety along with the vehicle weight reduction, thanks to the use of thinner components, and thus reducing the fuel consumption. The properties of the dual-phase steels are attributed to the chemical composition, type, size, amount and spatial distribution of different phases that can be obtained during thermomechanical treatments, namely, ferrite and martensite. In this way, modeling of the mechanical behavior of so-called advanced high strength steels, by considering a correct combination of the cited microstructural parameters, is essential to the numerical simulation of sheet metal forming processes. In this work, the microstructure of as-received DP600 cold rolled steel sheet with 1.2 mm nominal thickness was firstly characterized by means of scanning electron microscopy (SEM) technique. The grain sizes and volume fractions of ferrite and martensite phases were obtained by means of digital image analysis. Afterwards, a representative volume element (RVE) is obtained based on the DP600 real microstructure. From this RVE, a micromechanical finite element model is proposed considering the DP600 steel chemical composition, average grain size and mechanical properties of both ferrite and martensite phases. By assuming plane-stress conditions, both uniaxial and equibiaxial tension strain-paths were simulated and compared with the equivalent stress-strain curves determined from uniaxial tension along the sheet rolling direction and hydraulic bulge experiments. The numerical predictions of the uniaxial tension are in good agreement with the true stress-strain curve determined along the rolling direction. Moreover, the predicted local stress and strain fields indicated that the softer ferrite phase accumulated the most part of plastic strain. For larger plastic strains, as is the case of hydraulic bulge experiments, higher stress concentration is observed at the ferrite-martensite interface. The proposed RVE approach based on the real microstructure proved to be an important tool to evaluate both local and overall behaviors of dual-phase steels. Thus, this approach is a very promising tool to design tailored microstructures of advanced high strength steels.