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Virtual experimental study of microstructure design of dual phase steel for optimal formability

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The highly competitive automotive market demands for lightweight and safe vehicles. These requirements can be met using advanced high strength steels. Dual phase steel is a low carbon and low alloy steel consisting of usually 10-30% martensite and a ductile ferrite matrix. As this type of steel has high strength, high work hardening index and reasonable ductility, it is widely used in automotive applications such as structure parts and crash columns [1]. It is even a potential material for automotive outer panels. Because the formability demand for outer panel is high due to complex geometry and deformation mode, it is necessary to explore virtually the formability potential and limitations as a basic guideline for product development. In this research, different dual phase microstructures are virtually generated with a ferrite matrix of highly formable steel and different volume fraction of martensite by using Damask software [2]. The work hardening, plastic anisotropy, yield loci and formability performance are analysed via virtual experiments. The results indicate that firstly the strength of dual phase steels increases with increasing volume fraction of martensite. Secondly the plastic anisotropy r-value of dual phase steels is dominated by the texture of ferrite if the volume fraction is not higher than 10%. When the martensite volume fraction is higher than 20%, the r-value profile is strongly reduced. Thirdly, the martensite reduces the instantaneous deep drawing factor and so the deep drawing formability in general. However, martensite increases the stretching factor and the maximum value is reached in dual phase steel containing 10% to 20% martensite. Finally a good formability of dual phase steel is possible if the volume fraction of martensite is low and the γ-fibre texture of ferrite is strong.

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