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Development of High-Strength Dual Phase (DP) Steels with Enhanced Ductility

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Dual phase (DP) steels, consisting of a soft ferrite matrix and hard martensite phases, offer a desirable combination of high strength and good ductility. Typically, an increase in martensite phase-fraction leads to higher strength but reduced ductility. However, in this study, an opposite trend was observed, where the ductility improved despite an increase in martensite content. This study focuses on understanding this unexpected behavior and aims to establish the microstructure design principles as a fundamental study for developing high-strength DP steels without compromising ductility. A detailed analysis of tensile deformation behavior from a microstructural perspective, combined with an evaluation of mechanical properties based on chemical composition and crystallographic characteristics, was conducted to elucidate the underlying mechanisms. The findings revealed that continuous increase in strength with increasing martensite content is not always achievable. In particular, DP steels in this study exhibited decreased yield strength and enhanced ductility even with increasing the martensite fraction. This behavior appears to be influenced by the morphological characteristics of martensite, especially the differences between intragranular lath martensite and intergranular globular martensite. In addition, the effect of globular martensite formed at grain boundaries on the deformation behavior remains ambiguous, whether it is beneficial, detrimental, or neutral for the improvement of combined strength and ductility. It implies the need for a more nuanced approach to analyzing tensile deformation in DP steels based on martensite morphology and alloy composition. Thus, this study underscores the importance of microstructural control in optimizing the strength-ductility balance of DP steels. The presentation will discuss these findings and propose a microstructural design strategy for achieving enhanced ductility alongside high strength in DP steels.

Primary author: Dr OH, SEONGTAK (Hyundai Steel R&D Center)

Co-authors: Ms KIM, YOUNGWOO (Hyundai Steel R&D Center); Dr CHON, SEUNGHWAN (Hyundai Steel R&D Center)

Presenter: Dr OH, SEONGTAK (Hyundai Steel R&D Center)

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