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MEDIUM MANGANESE STEEL: REVEALING THE HIGH SENSITIVITY OF MICROSTRUCTURE AND MECHANICAL PROPERTIES ON INTERCRITICAL ANNEALING TEMPERATURE

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ABSTRACT

Medium manganese (Mn) steel is an important part 3rd generation advanced high strength steels (AHSS). Medium Mn steel grades are famous for overcoming the so-called "strength-ductility trade-off" that was the limitation in previous 1st generation AHSS. Medium Mn steels have high strength-ductility combination due to the ultrafine microstructure consisting of laths of martensite/ferrite along with a significant amount of interlath embedded austenite films. Austenite phase is stabilized in such steels via the austenite reverted transformation (ART) techniques or simply by the intercritical annealing (IA) treatment. In typical IA treatment, the sample with fully martensitic microstructure is held at an intercritical temperature during which partitioning of alloying elements such as carbon, manganese (austenite stabilizers) occurs from the intercritical ferrite to the intercritical austenite phase, thus lower the martensitic start (MS) temperature of the intercritical austenite phase and consequently increasing its thermal stability. Upon subsequent cooling to the room temperature, the microstructure retains sufficient austenite phase, owing to its increased stability. The retained austenite up on deformation exhibits various strain hardening mechanism like transformation induced plasticity (TRIP) and/or Twin induced plasticity (TWIP) that eventually imparts high strength-ductility combination to medium Mn steels. It is imperative to achieve ideal mechanical stability of austenite during IA. Stability of the retained austenite phase is dependent on various factors such as intercritical annealing temperature, annealing time, grain morphology, initial microstructure etc. Among these, the IA temperature is one of the most important parameters with respect to the austenite phase stability. There are various other factors affecting the final properties of the steel such as stacking fault energy and austenite grain size, are known to be indirectly associated with the IA temperature.

In the present study, the sensitiveness of the intercritical annealing temperature on microstructure and the ensuing mechanical properties of medium Mn steels is revealed. A correlation between the factors affecting the retained austenite stability and mechanical properties is established. The effect of stacking fault energy and austenite grain size is also assessed. It was found that the mechanical properties of the medium Mn steels vary significantly with a small variation in the intercritical annealing temperature.

Keywords: Medium Mn Steel; AHSS; Intercritial annealing; SFE