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Understanding of Molybdenum effects on the dynamic and static softening mechanisms in hot rolled low carbon steels: basic principles and processing implications

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Molybdenum is a well-known alloying element in steels, which in combination with other microalloying elements, is usually added to achieve high strength and high toughness property combinations. The effect of Mo retarding austenite recrystallization, both dynamically and statically, due to its strong solute drag effect, is the main mechanism acting during hot rolling. This contribution delves into the static and dynamic softening behavior of molybdenum-alloyed low carbon steels, aiming to elucidate its role during the different steps of the hot working process, from hot rolling down to phase transformation as well as the consequences in the final mechanical properties.
For that purpose, several low carbon steels with varying molybdenum contents were subjected to different thermomechanical processing conditions and the individual effects of composition and processing parameters were studied. Microstructural characterization employed advanced techniques like electron microscopy, EBSD and transmission electron microscopy to assess grain size, microstructural substructures and precipitate morphology.
Molybdenum addition was observed to pancake the austenite grain size during processing, leading to finer microstructures after transformation. The effect of Mo in the static and dynamic recrystallization kinetics was evaluated and its direct effect on critical processing temperatures, such as the non-recrystallization temperature, Tnr, was computed. The understanding of these base mechanisms helps designing appropriate rolling strategies. This way, and even under conditions of high finishing reduction sequences, molybdenum alloyed grades showed effective strain accumulation avoiding the onset of dynamic and/or static recrystallization. This reduced the possibility of finishing the rolling sequence with a mixed-grain structure, improving final microstructural homogeneities as well as improving toughness properties.
The findings provide valuable insights into the interplay between molybdenum, other alloying elements, microstructure, and softening mechanisms in low carbon steels. Tailoring molybdenum content and processing parameters can enable the design of microstructures with enhanced strength, toughness, and formability, catering to specific engineering applications.

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