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Designing thermomechanical processing schedules for Mo- and Cu-containing quenching and partitioning medium-Mn steels for multiphase forgings

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One of the most promising groups of steels for future forging applications are medium-manganese (medium-Mn) steels, which develop finely dispersed retained austenite (RA) during the quenching and partitioning (Q&P) heat treatment process.
RA between the martensitic laths significantly improves ductility and fracture resistance by impeding the propagation of microcracks through transformation-induced martensite formation.
Another challenge in the steel industry is the increasing presence of residual elements in recycled steel scrap, such as copper. As the concentration of copper in "green" steel is expected to rise in the future, understanding its impact on the thermal characteristics of steel is crucial.
In this study, three medium-Mn steels with a basic composition of 0.17%C-4%Mn-0.8%Al-0.5%Si, alloyed with molybdenum and copper, were subjected to Q&P heat treatment. The research involved a dilatometric study, initially focusing on the basic thermal analysis of the tested alloys, followed by the application of a wide range of temperature-time conditions representing the Q&P process. Both deformed and undeformed samples were analyzed to evaluate the impact of hot deformation on phase transformation kinetics. Subsequently, the steels underwent an integrated thermomechanical processing (simulating forging) and Q&P heat treatment using the Gleeble 3800 simulator, closely replicating industrial manufacturing conditions.
Following physical simulations in the dilatometer and Gleeble system, microstructural characterization was conducted using light microscopy and scanning electron microscopy (SEM). The fraction of RA was quantified through X-ray diffraction analysis. The results indicated that even small additions of alloying elements, such as 0.3% Mo and 1% Cu, influence critical temperatures and phase transformation kinetics, highlighting the necessity of tailoring heat treatment parameters to the specific chemical composition of the steel.

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Primary authors: Mr SKOWRONEK, Adam (Silesian University of Technology); Mr KASSAYE, Firew Tullu (Silesian University of Technology); Mr GULBAY, Oguz (RWTH Aachen University); Mr GRAMLICH, Alexander (RWTH Aachen University); Mr KRUPP, Ulrich (RWTH Aachen University); Mr GRAJCAR, Adam (Silesian University of Technology)

Presenter: Mr SKOWRONEK, Adam (Silesian University of Technology)

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