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Microstructural evolution and dynamic phase transformation of micro-alloyed steel during hot deformation and its impact on the 2nd ductility minimum

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Continuous casting of steel is widely used to manufacture semi-finished long or flat products. Various stresses are present during slab casting: the stress caused by the friction between the mould wall and the solidified shell, thermal stresses acting on the strand surface, and the stresses due to the bending and straightening operations. During casting, the combination of the temperature and deformation velocities may provoke ductility losses of the material. Steels present a minimum ductility point during continuous casting in the solid-state condition. In this work, we aim to answer the metallurgical reasons for the occurrence of the ductility minimum in a micro-alloyed steel by investigating the microstructural evolution. The samples are in situ melted via induction heating in the BETA250-5® thermomechanical simulator machine, followed by hot tensile tests conducted at different temperatures and strain rates. The ductility drop is analysed in the range of 650℃-1100℃ at different strain rates, 10-2 s-1 to 10-3 s-1. Furthermore, the study investigated the development of the ferrite phase at the prior austenite grain boundaries, the fraction and thickness of ferrite, dynamic phase transformation, and the influence of the test conditions on these parameters. The grain size, fracture mechanism, and ferrite fraction are determined from metallography investigations using optical microscopy (OM) and scanning electron microscopy (SEM). Finally, the microstructural changes are correlated to the ductility minimum using the measured results.

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