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High temperature oxidation in steel processing under different process conditions, atmospheres and rising levels on tramp elements

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The ongoing transformation to more sustainable production routes of the European steel industry is one of the major challenges in the upcoming years and is accompanied by a number of changes; 1) the use of a different raw material mix (more and lower scrap qualities), 2) the introduction of new processes or process combinations (e.g. direct casting and rolling processes) and 3) the use of alternative energy sources for reheating before hot rolling (e.g. reheating by hydrogen combustion or electrical reheating). These changes go hand in hand with a significant reduction of the CO2 footprint and with a different process control and expected product quality. Oxidation processes, which are unavoidable in continuous casting and further hot processing of steel, may have a negative impact on the surface quality and must be reconsidered with regards to this transformation.

In view of the changes, the understanding of the mechanisms behind high-temperature oxidation is of great importance: The interaction between external oxidation and internal oxidation, decarburization and liquid metal infiltration of grain boundaries will become essential for the retention of product quality under new operating conditions. These effects are influenced by parameters such as oxidation time, temperature, atmosphere and the chemical composition of the steel and the level of undesirable tramp elements such as Cu, Sn and Ni, which do not oxidize but accumulate at the bulk/scale interface or along surface-near grain boundaries.

To address these newly arising research questions a lab test setup was established: Utilizing Simultaneous-Thermal-Analysis in combination with various gas atmospheres (CO2, H2O, N2, O2, Ar), a precise investigation of surface oxidation phenomena in a wide variety of metallurgical processes became possible. The present work addresses selected results of continuous casting and reheating operations, where various process conditions were studied to accompany the transformation and make statements about new scenarios.

Primary author: PRESOLY, Peter (Montanuniversität Leoben)

Co-authors: GAISER, Georg (Montanuniversität Leoben); LITTRINGER, Robert (Chair of Ferrous Metallurgy, Montanuniversitaet Leoben); BERNHARD, Christian (Montanuniversitaet Leoben)

Presenter: PRESOLY, Peter (Montanuniversität Leoben)

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