Contribution ID: **147** Type: **Oral**

The Impact of Cu, Sn, and Ni on Surface Cracking in Continuous Casting

Tuesday 7 October 2025 14:30 (20 minutes)

Within the ongoing transformation of the steel industry towards lower CO2 emissions the share of steel produced via electric arc furnace will be rising. Depending on the input material (DRI/HBI, scrap, ⋯) the infiltration of undesirable tramp elements such as Cu, Sn and (Ni) may be unavoidable and due to their special properties removal from the liquid steel is hardly possible.
Defining the impact of Cu, Sn and Ni on the susceptibility to surface crack formation in continuous casting under near-process conditions presents a significant challenge, as it requires testing under oxidizing conditions. Recent publications have shown the superior possibilities of In-situ Material Characterization by Bending test (IMC-B) in investigating oxidation-related phenomena affecting surface crack formation. The experimental procedure involves solidification of the samples in a mold to achieve a microstructure similar to continuous casting, followed by controlled cooling in an air/water vapor atmosphere and deformation in an isothermal three-point bending test. In this study, a medium carbon construction steel was examined both with and without Cu, Sn, and Ni. The contents of Cu and Sn were set at 0.15 wt.% and 0.01 wt.%, reflecting the expected future levels of these elements in steel production, whereas Ni was added at 0.25 wt.%.
The results clearly indicate an increase in crack formation for the addition of Cu and Sn particularly in the temperature range of 900 to 1000 ℃. The rise in crack formation is attributed to the presence of low melting Cu-rich phases at the grain boundaries. In contrast, a bending temperature of 1100 ℃ was found to be uncritical. The addition of Ni effectively counteracts the crack formation caused by Cu and Sn, resulting in conditions similar to the base steel without any tramp elements.

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Session Classification: Continuous Casting Process Fundamentals & Defect Analysis

Track Classification: Steelmaking - Continuous casting, near-net shape casting and ingot casting