

Understanding the impact of residual impurities on the mechanical degradation of green steels

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Abstract

Martensitic steels remain among the most reliable materials for many structural applications owing to their distinctive microstructure and mechanical properties. Unfortunately, conventional steel production involves substantial CO₂ emissions and is therefore a major contributor to greenhouse gas emissions. One current strategy for cleaner steel production is the proposed use of recycled scrap in electric arc furnaces. However, the constituent impurities in iron scrap could be detrimental to the properties of steel by causing significant changes in the microstructure. To tackle this challenge, a systematic, in-depth analysis of the role of residual elements such as Cu, Sn, Sb, As, and P on the local and global mechanical properties of martensitic steel would provide insights to improve steel production. Hence, site-specific probing of the martensitic steel microstructure with residual element additions, using micromechanics, would be useful for a holistic mechanistic understanding of changes in engineering properties. Within this talk, we use nanoindentation and other indentation-based techniques, such as micro-pillar compression and micro-cantilever bending, to investigate how the hierarchical microstructure of martensite steel is influenced by residual elements. First, we observe minor changes in hardness attributable to residual effects, irrespective of processing conditions. In particular, the sample with Sn additions showed a substantial loss of hardness after tempering compared with the reference steel sample and samples with other residuals, which is indicative of the mechanical degradation of martensitic steels caused by the presence of residuals.

Detailed results of how the damage mechanisms of martensitic steels are influenced by residuals will be presented within the talk.

Keywords:

Residuals Nanoindentation Micro fracture Green steels