

The Department of Mechanical Engineering presents:

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Ausforming and Tempering of a Computationally Designed Ultra-High Strength Steel

Ferrium® M54® is a computationally designed ultra-high strength (UHS) steel with the potential for achieving outstanding strength, ductility, toughness and stress corrosion cracking resistance. M54 steel is currently being used in demanding areas, such as aerospace, defense, energy and construction, where high strength and toughness is needed while operating in extreme environments. Critical to the properties and performance of M54 steel is its hierarchical lath martensite microstructure which is further strengthened by finely dispersed, nanoscale carbide precipitates.

In this study, a novel thermomechanical controlled processing (TMCP) technique, ausforming, was investigated to reveal the relationships between processing, microstructure and mechanical properties of M54 and improve its performance. Ausforming was shown to be an effective way to significantly refine the martensitic microstructure and further enhance the properties of the novel UHS steel products. In addition, ausforming also proved to accelerate the age hardening behavior and reduced the necessary heat treatment time.

Ausforming was performed via single-pass high-reduction warm rolling in the current study with both pilot-scale and full-scale trials. The effect of ausforming parameters on microstructure and mechanical properties was investigated and the ausforming parameters were optimized. The processability and scalability of the ausforming process were also discussed. Subsequent to ausforming, isothermal tempering studies were conducted to look into the effects of severe ausforming on M_2C carbide precipitation in M54. The combined effects of microstructural refinement and nanoprecipitate strengthening maximized the combination of strength and ductility.