



Continuous slab caster at a United States Steel facility.



Continuous electrolytic tinning line at a U.S. Steel facility.



Steel blast furnace being tapped at United States Steel.

IRON AND STEEL: STEEL PRODUCT METALLURGY AND APPLICATIONS

This article contains summaries of six of the more than 60 papers to be presented in this group of sessions. You can see abstracts of all of the other presentations at www.matscitech.org.

MATERIAL AND DESIGN CONSIDERATIONS FOR HOT-STAMPED BORON STEEL COMPONENTS IN AUTOMOTIVE STRUCTURES

Raj Mohan Iyengar, Severstal North America

The demand for fuel economy and the stringent requirements for automobile safety have required automakers to emphasize strength over stiffness in designing lightweight body structures. The change in emphasis has necessitated the exploitation of ultrahigh-strength steels to achieve improved crashworthiness and durability in automotive vehicles. In this paper, the viability of hot-stamped boron steels in high-performance automotive structures will be discussed. A brief description of the hot-stamping process will be followed by recent mechanical property data that underscore the superiority of boron steels in enabling the development of safe and fuel-efficient vehicles. The relatively low-carbon and low-alloy content of boron steels enable better weldability compared with high-carbon and high-alloy steels.

EFFECT OF CARBON CONTENT ON THE MICROSTRUCTURE AND THE TRANSFORMATION KINETICS OF SUPER BAINITIC TRIP STEEL

Kyooyoung Lee, POSCO

TRIP steels (TRansformation Induced Plasticity) with $TS \times El > 30,000$ MPa in the region of X-AHSS are under development to meet demands for both ultrahigh strength and enhanced formability. Finer bainitic microstructures related to low-temperature transformations in high-carbon TRIP steel is known to be beneficial for ultrahigh strength above 2 GPa. However, the bainitic transformation is very sluggish due to the high carbon content and very low transformation temperature, and it takes several days. In this study, the effect of carbon content on transformation time was investigated in relation to mill processes as well as bainitic plate thickness. As a result of the study, transformation time was reduced to several hundred seconds by reducing carbon contents, and the plate thickness obtained was in good agreement with that predicted by theoretical calculations.

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IRON AND STEEL SYMPOSIA AT MS&T'08

- New Developments in Processing and Properties of Zinc-Coated Sheet Steels
- International Symposium on Materials Engineering for Structural Applications
- Advancements in Steel Production through EAF, Ladle Refining, and Continuous Casting Technologies and Practice
- Recent Developments in Steel Processing
- Steel Product Metallurgy and Applications

COMPUTER MODELING OF INDUCTION HEATING PROCESSES TO ENSURE SUPERIOR COIL DESIGNS

Valery Rudnev, *Inductoheat Inc.*

Computer modeling of induction heating to show pros and cons of popular numerical modeling techniques including finite difference method, finite element analysis, mutual impedance method, and the boundary element method are evaluated. Nonlinearity of material properties, including thermal conductivity, emissivity, specific heat, electrical resistivity and magnetic permeability, as well as convection and radiation thermal surface losses, are taken into consideration. How different factors may impact transitional and final heating conditions is analyzed. Case studies include multi-frequency in-line multi-coil induction heating of billets, rods, and bars; and induction surface hardening and tempering of complex-shape parts (i.e., crankshafts, camshafts, gears).

CHARACTERIZATION OF X100 LINE PIPE MATERIAL

Shahrooz Nafisi, *IPSCO*

Extensive studies to develop Grade X100 line pipe for strain based design have been conducted. To improve the physical properties of the pipes, several different chemistries and microstructural control technologies were evaluated. The microstructure of this material consists mainly of a mixture of non-polygonal, acicular, and bainitic ferrite. Usually, characterization of microstructures has been based on visualization through an optical or scanning electron microscope. In this study, EBSD has been used to quantitatively analyze these complex microstructures.

MICROSTRUCTURE AND TOUGHNESS OF MARTENSITIC STEEL

John Morris, *University of California, Berkeley*

The creation of a tough martensitic steel begins with the substructure of the martensite itself, which

must be dislocated, normally lath martensite. To minimize elastic energy, the austenite grains within such a steel subdivide during transformation into "blocks" in which laths of dislocated martensite are in close crystallographic alignment. The crystallographic relation between blocks permits grain refinement for toughness: the microstructure may be made ultrafine-grained with respect to fracture without becoming so strong (via the Hall-Petch effect) that toughness is lost to high strength. This grain refinement can be accomplished in at least two ways: by direct "block refinement" through appropriate thermal or thermomechanical processing, or by intercritical treatments that interpose layers of crystallographically active austenite along inter-lath boundaries within the packets.

ADVANCED HIGH STRENGTH STEELS (AHSS) WITH DUPLEX FERRITE AND AUSTENITE MICROSTRUCTURES

Meghan McGrath, *Missouri University of Science and Technology*

This paper will present preliminary work on third-generation advanced high strength steels with acicular ferrite and austenite microstructures. Inoculation of intragranular ferrite was investigated by exploring a two stage deoxidation practice; partial deoxidation with aluminum and finishing deoxidation with titanium. According to the literature, the titanium oxide will coat the alumina particles and provide effective nucleation sites for intragranular ferrite. A base chemistry of 5Mn, 1.5Si, 0.35C, 0.3Mo and 0.005B was evaluated in these experiments. Elevated levels of manganese and nitrogen were used to increase the strength of the parent austenite phase and subsequently reduce the ferrite plate thickness to a nanoscale. A microstructural study as a function of cooling rate was performed using the Jominy end-quench test, and these microstructures were compared to microstructures produced by austempering. ●

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