

# steel research

international

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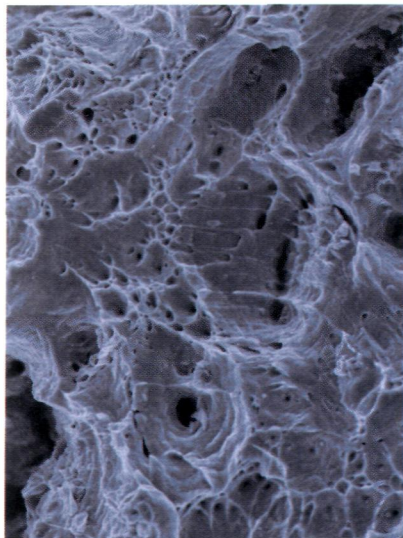
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# 2013

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## Cover Photo:

This cover shows 316L stainless steels brittle fracture behavior after charged with hydrogen. Hydrogen embrittlement in steels is still an important subject for their use in nuclear power plants and gas/oil industry. More details on how it can be tested and examined can be found in the manuscript by Y. Kim et al.

## Publishing company:

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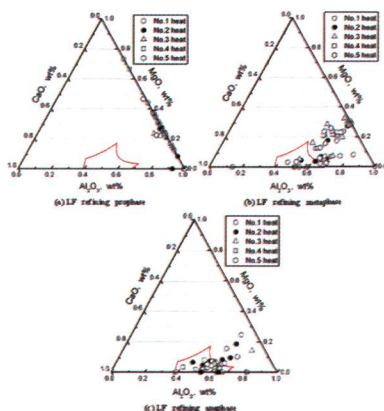
## Contents

### Full Paper

Y. Jun\*, C. Bo-Tao, T. Wei, Z. Fan-Zheng,  
Y. Gang, and S. Feng

Experimental Study to Improve the  
Castability of Aluminum Killed Cold  
Heading Steel

703

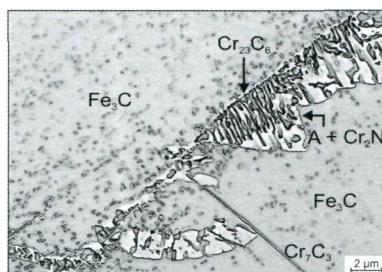


The aluminum deoxidized products were transformed from  $Al_2O_3$  to the complex inclusions  $CaO-MgO-Al_2O_3$  with lower melting point by adjusting the compositions of LF refining top slag. The inclusions are in liquid state and can be easily floated up during LF refining and continuous casting. This method needs a little or no calcium treatment to obtain favorable castability of molten steel.

H. Berns\* and K. Geenen\*

Hot Strength and Creep Resistance  
of a High Interstitial Austenitic CrMn  
Steel

713

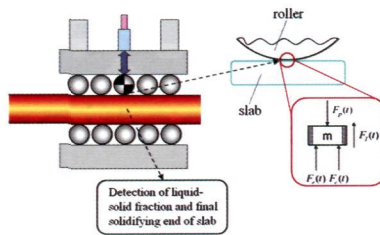


The hot strength and short-time creep resistance of an austenitic CrMn steel with 0.85 mass% C+N is investigated up to 700°C. Microstructural changes are revealed by SEM and TEM-SAD. The creep resistance is above that of tempered martensitic CrMoV hot-work tool steel.

# Contents

Z. Wang, X. Wang, F. Liu, M. Yao\*,  
X. Zhang, L. Yang, H. Lu and X. Wang  
**Vibration Method to Detect Liquid-Solid Fraction and Final Solidifying End for Continuous Casting Slab**

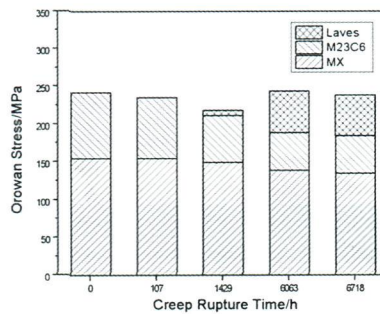
724



Accurate measurement of liquid-solid fraction of casting slab in secondary cooling zone and precise prediction of final solidifying end have momentous significances for internal defects improvement of slabs. Basing on theoretical deduction, physical experiment, and numerical simulation, a new measuring approach is proposed and the results provide guidance for on-line detection of liquid-solid fraction and final solidifying end of slab.

J. Jiang, L. H. Zhu\* and Y. F. Wang  
**Hardness Variation in P92 Heat-Resistant Steel based on Microstructural Evolution during Creep**

732

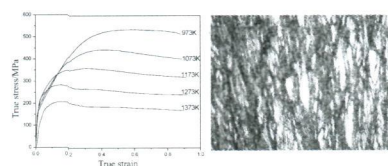


The microstructural evolution in P92 steel during creep has been investigated and the effects of Laves phase,  $M_{23}C_6$ , and MX on the variation of hardness are quantified. Results show that the coarsening of  $M_{23}C_6$  is the main factor to decrease the hardness at early stage of creep. The hardness increases again owing to the precipitation of a large amount of Laves phase after creeping a period of time. However, the coarsening of Laves phase leads to the decline in hardness.

D. Z. Li, Y. H. Wei\*, C. Y. Liu, and L. F. Hou

**Hot Deformation Behaviors of Fe-30Mn-3Si-3Al TWIP Steel during Compression at Elevated Temperature and Strain Rate**

740

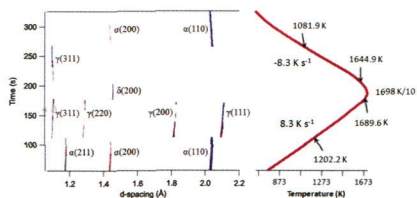


The optimum hot-working parameters are temperatures of 1223–1323K, and strain rates of  $1-10 \text{ s}^{-1}$ . The recrystallization structures gradually spread along the austenitic boundaries and exhibit a necklace shape, and DRX mechanism is a boundary bulge mechanism. The investigation results characterize the hot-working conditions for acceptable formability and usability of TWIP steel. The stress-strain curves of TWIP steels deformed under strain rate of  $10^{-1}$  with various temperatures, and corresponding microstructure of the sample deformed at 1073 K.

# Contents

X.-F. Zhang\* and Y. Komizo  
In Situ Investigation of the Allotropic Transformation in Iron

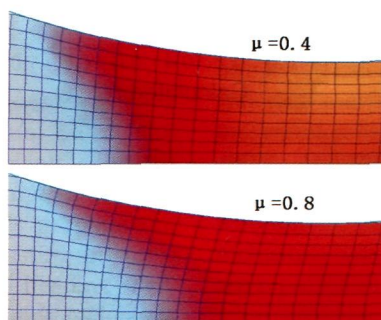
EDITOR'S CHOICE 751



Advanced in situ observation systems consisting of laser scanning confocal microscopy and time-resolved X-ray diffraction using a synchrotron are developed to track the microstructural changes on a micron scale under a rapid heating and cooling cycle. The diffraction pattern of iron collected by this technique is shown in the figure. It exhibits the patterns, horizontal, evolving in *d*-spacing and increasing time, vertical. An allotropic transformation takes place, seen by vanishing and increasing intensity lines.

M. X. Jia, Y. P. Lü, L. F. Xu\* and Y. P. Song  
The Influence of Friction on the Texture Formation of a IF Steel during Hot Rolling in the Ferrite Region

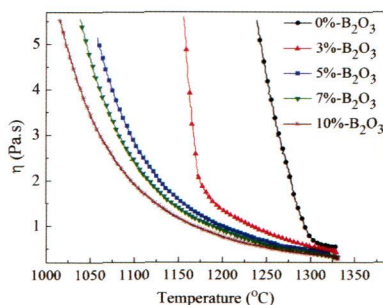
761



The effect of friction on microstructure and texture formation of an IF steel during hot rolling in the ferrite region is investigated by means of experiment and finite element simulation. During hot rolling without lubricant, the friction results in the through-thickness variation of shear strain and large  $\epsilon_{13}/\epsilon_{11}$  value at the sheet surface, which leads to through-thickness texture gradients.

Z. Wang, Q. Shu\* and K. Chou  
Viscosity of Fluoride-Free Mold Fluxes Containing B<sub>2</sub>O<sub>3</sub> and TiO<sub>2</sub>

766



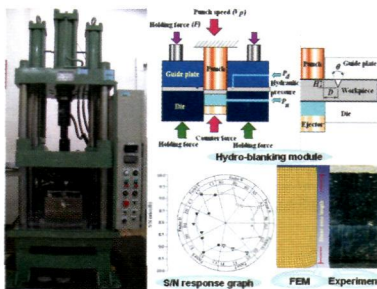
Both the increase of B<sub>2</sub>O<sub>3</sub> and TiO<sub>2</sub> content could lead to decrease of the viscosities of fluoride-free mold fluxes containing B<sub>2</sub>O<sub>3</sub> and TiO<sub>2</sub>. The modified Riboud model based on the present experimental data could be used to estimate the viscosities of fluoride-free slag system, and the results of calculation and measurement are in good agreement.

# Contents

J.-P. Wang\*, G.-M. Huang, H.-D. Lee,  
C.-C. Chen, T.-T. Chen, C.-L. Chen

## Optimization of Fine Hydro-Blanking

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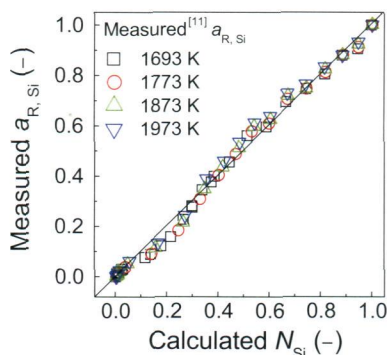


A hydro-blanking mechanism is designed to substitute the conventional fine blanking. The Taguchi-FE method combined with the hybrid system (the combination approach of ANN and GA) is used to find the optimal solution. It is concluded that the fine hydro-blanking approach has the same effects as the conventional fineblanking.

X. M. Yang\*, M. Zhang, P. C. Li,  
J. Y. Li and J. Zhang

## A Thermodynamic Model for Representation Reaction Abilities of Structural Units in Full Composition Range of Fe-Si Binary Melts Based on the Atom-Molecule Coexistence Theory

784

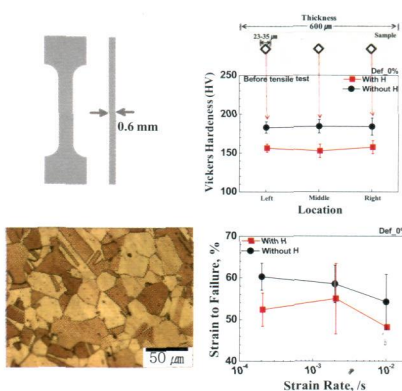


The cover shows the accurate agreement between the calculated mass action concentration  $N_{Si}$  of Si and the reported activity  $a_{R,Si}$  of Si relative to pure liquid Si(l) as standard state by Chipman et al. in the full composition range of Fe-Si binary melts at temperatures of 1693, 1773, 1873, and 1973 K, respectively. The determined mass action concentration  $N_{Si}$  of Si in Fe-Si binary melts can be successfully applied to predict the reaction ability like the defined activity  $a_{R,Si}$  of Si in the investigated temperature range.

Y. Kim, D. Shin, Y. Kim, D. W. Kim,  
S. Kim, W. Nam, Y.-S. Kim, K. Máthis  
and H. Choe\*

## Hydrogen Softening in the Thin Plate of Microcrystalline 316L Stainless Steel

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316L austenite stainless steels have attracted considerable attention as advanced structural materials in nuclear power plants because of their high strength and large ductility, good fracture toughness, good corrosion resistance as well as low absorption rate of neutrons. Thin-plate specimens of 316L were charged with hydrogen using a cathodic charging technique. Despite the short diffusion distance of hydrogen predicted by the diffusion-controlled model for a semi-infinite sheet, Vickers hardness measurements and roomtemperature tensile results revealed the full effect of hydrogen in the center of cross-sections of the thin-plate specimens as well as in the vicinity of the outer surfaces.

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