PALESTRA DO PROFESSOR CHRIS PISTORIUS -

CARNEGIE MELLON UNIVERSITY

ESTADOS UNIDOS

“Finding and Tweaking Inclusions in Steel”

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Sala de Seminários 1010

Bloco de Ligação

Escola de Engenharia da UFMG

AIST ASSOCIATION FOR IRON & STEEL TECHNOLOGY

John F. Elliott LECTURER

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LECTURE

The AIST John F. Elliott Lectureship was established in 1990. This honorary lectureship is designed to acquaint students and engineers with the exciting opportunities in chemical process metallurgy; inspire them to pursue careers in this field; inform the public of the contributions of chemical process metallurgy and materials chemistry to the association; and honor the late Professor John Elliott of the Massachusetts Institute of Technology for his many accomplishments and the leadership that he provided during his career.

BIOGRAPHY

P. Chris Pistorius

Chris Pistorius is POSCO Professor and Co-Director of the Center for Iron and Steelmaking Research in the Department of Materials Science and Engineering at Carnegie Mellon University. His research focuses on pyrometallurgy, solidification and electrochemistry. He was an associate professor (1991–1996) and professor (1997–2008) in the Department of Materials Science and Metallurgical Engineering, University of Pretoria, South Africa, and served as the chair of that department from May 2002 to June 2008. Chris has a master’s degree in metallurgical engineering from the University of Pretoria, and a Ph.D. from the University of Cambridge, United Kingdom.

ABSTRACT

Finding and Tweaking Inclusions in Steel

Inclusions matter: Oxide inclusions in steel must be managed for reliable steel processing (casting and rolling) and predictable final properties. The allowable inclusion sizes and concentrations in steel products have steadily decreased over time.

Inclusions are measurable: Recent improvements in automated scanning electron microscopy allow plant engineers and researchers to analyze — within minutes to tens of minutes — the prevalence, size, spatial distribution and chemical composition in steel. Quantification of inclusions enables better quality control, with the ability to track changes over time within a single heat and for many heats.

Inclusions change during steel processing: Whether intentionally or inadvertently, inclusions change (in size, shape, chemistry and prevalence) on the time scale of secondary metallurgy. These changes occur through several mechanisms: (1) transfer of elements from slag to inclusions through liquid steel; for example, formation of spinels in aluminum-killed steel; (2) intentional addition of calcium to modify solid alumina or spinels to liquid calcium aluminates; (3) reoxidation, delivering a fresh population of inclusions; (4) entrainment of small slag or flux droplets; (5) alloying additions; and (6) refractory wear.

Inclusions can be controlled: Through knowledge of the underlying mechanisms, reliable mathematical models of inclusions reactions, fast microscopy and improved plant practices, clean steel can be produced reliably.