



# Electroslag refining with liquid metal for composite rotor manufacturing

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## ABSTRACT

**Purpose:** To develop novel ESR based process for composite ingot with shallow transition zone between layers in order to produce efficient heavy-weight rotors for steam turbines.

**Design/methodology/approach:** The nowadays heavy-weight rotors for steam turbines for power plants are monoblock or two or more layer in length composite part facilitating operation in different zones withstanding various loads and working medium. However, the joining of various steel in composite rotors by welding has low productivity. The ESR now is recognised as the best available technology for the big-diameter and mass forgings for power generating machines, including rotor ones. The ESR affords the most favourable conditions of solidification resulting in homogenous low-segregation ingot with smooth surface and high-quality structure. The step ahead is the ESR for composite.

**Findings:** The two-layer model ingot had produced from steel grades 12Cr13 and 35NiCrMoV12-5 were manufactured using the electroslag process with the liquid metal (ESR LM) in the CSM of 180 mm in diameter with ingot withdrawing. The transition zone in two-layer ingot had have the shallow shape and low depth with the even macrostructure without defects of the same type as both joined steels. The metal of the transition zone fully satisfies standard requirements for properties of both steel grades in the heat treated and as-cast conditions.

**Research limitations/implications:** The ESR LM can provide both the monobloc heavy ingots with uniform structure and composites with low-stress connection between metal layers for heavyweight rotors and other critical products manufacturing.

**Keywords:** ESR LM, Composite ingot, Heavy rotor, Transition zone, Heat treatment, Microstructure, Mechanical properties

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## PROPERTIES

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**Chengbin Shi,Jing Li,Shufeng Yang**



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*Electroslag Refining* Sheffield Metallurgical and Engineering Association, 1973

**Clean Steel** Chengbin Shi, Jing Li, Shufeng Yang, 2023-06-22 This book introduces the results that the authors have achieved on the study of functional principle of electroslag remelting for production of high quality clean steel The dependence of oxygen sulfur and non metallic inclusions on the processing parameters of electroslag remelting is assessed The fundamentals and technologies of clean steel production by electroslag remelting have been applied in the round to discuss oxygen sulfur and non metallic inclusions evolution and control A general concluding remark and a perspective for future work are present The book is likely to be of interest to university teachers researchers R D engineers and graduate students in material processing and pyrometallurgy who wish to explore innovative technologies that lead to more energy efficient and environmentally sustainable clean steel production

*13th International Conference on Aluminum Alloys (ICAA 13)* Hasso Weiland, Anthony Rollett, William Cassada, 2017-02-28 This is a collection of papers presented at the 13th International Conference on Aluminum Alloys ICAA 13 the premier global conference for exchanging emerging knowledge on the structure and properties of aluminum materials The papers are organized around the topics of the science of aluminum alloy design for a range of market applications the accurate prediction of material properties novel aluminum products and processes and emerging developments in recycling and applications using both monolithic and multi material solutions

**Proceedings of the 2013 International Symposium on Liquid Metal Processing and Casting** Matthew Krane, Alain Jardy, Rodney Williamson, Joseph Beaman, 2016-12-06

**Proceedings of the 9th International Symposium on Superalloy 718 & Derivatives: Energy, Aerospace, and Industrial Applications** Eric Ott, Xingbo Liu, Joel Andersson, Zhongnan Bi, Kevin Bockenstedt, Ian Dempster, Jon Groh, Karl Heck, Paul Jablonski, Max Kaplan, Daisuke Nagahama, Chantal Sudbrack, 2018-05-12 This technical meeting will focus on Alloy 718 and Superalloys in this class relative to alloy and process development production product applications trends and the development of advanced modeling tools The symposium provides an opportunity for authors to present technical advancements relative to a broad spectrum of areas while assessing their impact on related fields associated with this critical alloy group There are continuing innovations relative to these alloys as well as novel processing techniques which continue to extend applications in very challenging environments ranging from corrosion resistance in the deep sea to high stressed space applications

Proceedings of the International Conference on Environmental Management in Metallurgical Industries (EMMI-2000), 2000

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**Fluid Flow Phenomena In Metals Processing** Julian Szekely, 2012-12-02 Fluid Flow Phenomena in Metals Processing outlines the fundamentals of fluid flow theory emphasizing the potential applications of fluid flow concepts that are illustrated by actual problems drawn from the metallurgical literature This book is divided into 10 chapters Chapters 1 to 4 are devoted to the fundamentals of fluid flow while Chapters 5 to 9 are concerned with the application of basic

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