



# Modeling of the Formation of AlN Precipitates During Solidification of Steel

D. Kalisz\*, S. Rzażko

AGH University of Science and Technology,  
Reymonta 23, 30-059 Kraków, Poland

\* Corresponding author. E-mail address: dorotakap@poczta.onet.pl

Received 13.07.2012; accepted in revised form 04.09.2012

## Abstract

The study was carried out computer simulations of the formation process of AlN precipitates in the solidification of steel. The chemical composition of steel and non-metallic inclusions formed was determined using the commercial software FactSage. Calculated amount of precipitates formed during cooling of steel between the liquidus and solidus temperatures under conditions of thermodynamic equilibrium. In parallel, the computations were performed using your own computer program. It was found that aluminum nitride is formed at the final stage of solidification, and the condition of its formation is low oxygen content in steel.

**Keywords:** Computer simulation, Aluminum nitride, Solidification of steel, Continuous casting of steel, Silicon steel

## 1. Introduction

Formation of non-metallic inclusions in steel ingot obtained in continuous casting machine (CCM) is a complex process. The chemical composition, size and spatial distribution influence the structure and properties of cast ingot. The initial non-metallic inclusions resulting from steel de-oxidation are in major part removed in ladle, mainly during argon purging and the remainder should be removed in castin tundish. In the ideal case, the steel tapped into the casting mould might be almost inclusions free. However, in casting mold new inclusions are produced in liquid steel for two reasons: decrease of equilibrium solubility product with decreasing temperature and segregation of liquid steel components at the solidification front. These secondary inclusions may play an important role in structure formation. The development of technology of steel refining in ladle and casting tundish, so called tertiary metallurgy, allows for assure the relevant conditions for required structure and properties of the ingot. In high grade steels and specific purpose steels the kind of emerging inclusions, their chemical composition, dimensions and

total amount are crucial for optimal steel properties. The present work deals with the process of AlN precipitates formation during steel solidification. The AlN play very important role in steel structure formation, which is particularly important in obtaining high magnetic properties of grain oriented high silicon steel [1]. As aluminum shows high chemical affinity to both oxygen and nitrogen in steel, the correct determination of the conditions favourable for AlN formation is rather complicated task [2], [3] [4], [5]. The aim of the present work was the computer simulation of steel components distribution between phases, with special focus on AlN formation. The obtained results are verified with the results of steel sample analysis by means of transmission electron microscopy.

## 2. The object of research

The simulation of AlN precipitation in the course of steel solidification in continuously cast ingot was carried out for high silicon grain oriented steel (Polish designation ET2), assigned for

# Formation Properties Of Precipitates

**G Thomas**

A decorative graphic element consisting of a light blue horizontal bar with a rounded right end, and a red-to-white gradient semi-circle overlapping the right side of the bar.

## **Formation Properties Of Precipitates:**

This Captivating World of E-book Books: A Comprehensive Guide Unveiling the Pros of E-book Books: A Realm of Convenience and Versatility E-book books, with their inherent mobility and ease of access, have liberated readers from the constraints of physical books. Done are the days of carrying bulky novels or meticulously searching for particular titles in shops. Kindle devices, sleek and lightweight, effortlessly store an extensive library of books, allowing readers to immerse in their favorite reads whenever, anywhere. Whether traveling on a bustling train, relaxing on a sunny beach, or just cozying up in bed, Kindle books provide an unparalleled level of ease. A Reading World Unfolded: Exploring the Vast Array of E-book Formation Properties Of Precipitates Formation Properties Of Precipitates The E-book Store, a digital treasure trove of bookish gems, boasts an wide collection of books spanning diverse genres, catering to every readers preference and choice. From gripping fiction and thought-provoking non-fiction to classic classics and modern bestsellers, the E-book Shop offers an exceptional abundance of titles to discover. Whether seeking escape through engrossing tales of imagination and adventure, diving into the depths of past narratives, or broadening ones knowledge with insightful works of science and philosophy, the E-book Shop provides a gateway to a bookish world brimming with limitless possibilities. A Revolutionary Force in the Literary Landscape: The Lasting Impact of Kindle Books Formation Properties Of Precipitates The advent of Kindle books has unquestionably reshaped the literary scene, introducing a model shift in the way books are published, disseminated, and read. Traditional publishing houses have embraced the online revolution, adapting their strategies to accommodate the growing demand for e-books. This has led to a surge in the accessibility of E-book titles, ensuring that readers have access to a vast array of literary works at their fingertips. Moreover, E-book books have equalized entry to literature, breaking down geographical barriers and providing readers worldwide with equal opportunities to engage with the written word. Regardless of their location or socioeconomic background, individuals can now immerse themselves in the captivating world of literature, fostering a global community of readers. Conclusion: Embracing the Kindle Experience Formation Properties Of Precipitates Kindle books Formation Properties Of Precipitates, with their inherent ease, versatility, and vast array of titles, have certainly transformed the way we experience literature. They offer readers the liberty to discover the boundless realm of written expression, whenever, anywhere. As we continue to navigate the ever-evolving digital landscape, Kindle books stand as testament to the lasting power of storytelling, ensuring that the joy of reading remains accessible to all.

[https://cheaperseeker.com/About/Resources/Download\\_PDFS/Exploring\\_World\\_Communities\\_3.pdf](https://cheaperseeker.com/About/Resources/Download_PDFS/Exploring_World_Communities_3.pdf)

### Table of Contents Formation Properties Of Precipitates

1. Understanding the eBook Formation Properties Of Precipitates
  - The Rise of Digital Reading Formation Properties Of Precipitates
  - Advantages of eBooks Over Traditional Books
2. Identifying Formation Properties Of Precipitates
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Formation Properties Of Precipitates
  - User-Friendly Interface
4. Exploring eBook Recommendations from Formation Properties Of Precipitates
  - Personalized Recommendations
  - Formation Properties Of Precipitates User Reviews and Ratings
  - Formation Properties Of Precipitates and Bestseller Lists
5. Accessing Formation Properties Of Precipitates Free and Paid eBooks
  - Formation Properties Of Precipitates Public Domain eBooks
  - Formation Properties Of Precipitates eBook Subscription Services
  - Formation Properties Of Precipitates Budget-Friendly Options
6. Navigating Formation Properties Of Precipitates eBook Formats
  - ePub, PDF, MOBI, and More
  - Formation Properties Of Precipitates Compatibility with Devices
  - Formation Properties Of Precipitates Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Formation Properties Of Precipitates
  - Highlighting and Note-Taking Formation Properties Of Precipitates
  - Interactive Elements Formation Properties Of Precipitates
8. Staying Engaged with Formation Properties Of Precipitates

- Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Formation Properties Of Precipitates
9. Balancing eBooks and Physical Books Formation Properties Of Precipitates
- Benefits of a Digital Library
  - Creating a Diverse Reading Collection Formation Properties Of Precipitates
10. Overcoming Reading Challenges
- Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Formation Properties Of Precipitates
- Setting Reading Goals Formation Properties Of Precipitates
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Formation Properties Of Precipitates
- Fact-Checking eBook Content of Formation Properties Of Precipitates
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

### **Formation Properties Of Precipitates Introduction**

In today's digital age, the availability of Formation Properties Of Precipitates books and manuals for download has revolutionized the way we access information. Gone are the days of physically flipping through pages and carrying heavy textbooks or manuals. With just a few clicks, we can now access a wealth of knowledge from the comfort of our own homes or on the go. This article will explore the advantages of Formation Properties Of Precipitates books and manuals for download, along with some popular platforms that offer these resources. One of the significant advantages of Formation Properties Of Precipitates books and manuals for download is the cost-saving aspect. Traditional books and manuals can be costly,

especially if you need to purchase several of them for educational or professional purposes. By accessing Formation Properties Of Precipitates versions, you eliminate the need to spend money on physical copies. This not only saves you money but also reduces the environmental impact associated with book production and transportation. Furthermore, Formation Properties Of Precipitates books and manuals for download are incredibly convenient. With just a computer or smartphone and an internet connection, you can access a vast library of resources on any subject imaginable. Whether you're a student looking for textbooks, a professional seeking industry-specific manuals, or someone interested in self-improvement, these digital resources provide an efficient and accessible means of acquiring knowledge. Moreover, PDF books and manuals offer a range of benefits compared to other digital formats. PDF files are designed to retain their formatting regardless of the device used to open them. This ensures that the content appears exactly as intended by the author, with no loss of formatting or missing graphics. Additionally, PDF files can be easily annotated, bookmarked, and searched for specific terms, making them highly practical for studying or referencing. When it comes to accessing Formation Properties Of Precipitates books and manuals, several platforms offer an extensive collection of resources. One such platform is Project Gutenberg, a nonprofit organization that provides over 60,000 free eBooks. These books are primarily in the public domain, meaning they can be freely distributed and downloaded. Project Gutenberg offers a wide range of classic literature, making it an excellent resource for literature enthusiasts. Another popular platform for Formation Properties Of Precipitates books and manuals is Open Library. Open Library is an initiative of the Internet Archive, a non-profit organization dedicated to digitizing cultural artifacts and making them accessible to the public. Open Library hosts millions of books, including both public domain works and contemporary titles. It also allows users to borrow digital copies of certain books for a limited period, similar to a library lending system. Additionally, many universities and educational institutions have their own digital libraries that provide free access to PDF books and manuals. These libraries often offer academic texts, research papers, and technical manuals, making them invaluable resources for students and researchers. Some notable examples include MIT OpenCourseWare, which offers free access to course materials from the Massachusetts Institute of Technology, and the Digital Public Library of America, which provides a vast collection of digitized books and historical documents. In conclusion, Formation Properties Of Precipitates books and manuals for download have transformed the way we access information. They provide a cost-effective and convenient means of acquiring knowledge, offering the ability to access a vast library of resources at our fingertips. With platforms like Project Gutenberg, Open Library, and various digital libraries offered by educational institutions, we have access to an ever-expanding collection of books and manuals. Whether for educational, professional, or personal purposes, these digital resources serve as valuable tools for continuous learning and self-improvement. So why not take advantage of the vast world of Formation Properties Of Precipitates books and manuals for download and embark on your journey of knowledge?

### FAQs About Formation Properties Of Precipitates Books

**What is a Formation Properties Of Precipitates PDF?** A PDF (Portable Document Format) is a file format developed by Adobe that preserves the layout and formatting of a document, regardless of the software, hardware, or operating system used to view or print it. **How do I create a Formation Properties Of Precipitates PDF?** There are several ways to create a PDF: Use software like Adobe Acrobat, Microsoft Word, or Google Docs, which often have built-in PDF creation tools. Print to PDF: Many applications and operating systems have a "Print to PDF" option that allows you to save a document as a PDF file instead of printing it on paper. Online converters: There are various online tools that can convert different file types to PDF. **How do I edit a Formation Properties Of Precipitates PDF?** Editing a PDF can be done with software like Adobe Acrobat, which allows direct editing of text, images, and other elements within the PDF. Some free tools, like PDFescape or Smallpdf, also offer basic editing capabilities. **How do I convert a Formation Properties Of Precipitates PDF to another file format?** There are multiple ways to convert a PDF to another format: Use online converters like Smallpdf, Zamzar, or Adobe Acrobat's export feature to convert PDFs to formats like Word, Excel, JPEG, etc. Software like Adobe Acrobat, Microsoft Word, or other PDF editors may have options to export or save PDFs in different formats. **How do I password-protect a Formation Properties Of Precipitates PDF?** Most PDF editing software allows you to add password protection. In Adobe Acrobat, for instance, you can go to "File" -> "Properties" -> "Security" to set a password to restrict access or editing capabilities. Are there any free alternatives to Adobe Acrobat for working with PDFs? Yes, there are many free alternatives for working with PDFs, such as: LibreOffice: Offers PDF editing features. PDFsam: Allows splitting, merging, and editing PDFs. Foxit Reader: Provides basic PDF viewing and editing capabilities. How do I compress a PDF file? You can use online tools like Smallpdf, ILovePDF, or desktop software like Adobe Acrobat to compress PDF files without significant quality loss. Compression reduces the file size, making it easier to share and download. Can I fill out forms in a PDF file? Yes, most PDF viewers/editors like Adobe Acrobat, Preview (on Mac), or various online tools allow you to fill out forms in PDF files by selecting text fields and entering information. Are there any restrictions when working with PDFs? Some PDFs might have restrictions set by their creator, such as password protection, editing restrictions, or print restrictions. Breaking these restrictions might require specific software or tools, which may or may not be legal depending on the circumstances and local laws.

### Find Formation Properties Of Precipitates :

**exploring world communities 3.**

[exploring careers through volunteerism](#)

experiments in applied microbiology

*exploring the unconscious*

exploring the human body reproducti

experimental psychology

experimentation with animal models in space volume 10 advances in space biology and medicine

**experiments for the electric circuits laboratory**

explorations in social theory and philippine ethnography

**exploring grand junction**

*export austrian architecture in europeosterreichische architekten bauen fur europa*

**exploring chemistry**

exploring chiang mai city valley and mountains

expert systems for civil engineers inte

*experiments in fundamental concepts of biology*

### **Formation Properties Of Precipitates :**

Ditch Witch R-65 Trencher Parts Manual This parts catalog will provide detailed information on how to dismantle your machine through exploded views of the parts and components of your equipment ... Ditch Witch R-65 Trencher Parts Manual This Operation Instructions and Parts List manual has · been designed to provide you a quick. simple. easy-to-use · reference for ordering "Genuine DITCH WITCH ... Ditch Witch R-65 Trencher Chassis Operators Manual ... Ditch Witch R-65 Trencher Chassis Operators Manual Parts Catalog ; Item Number. 255888136739 ; Compatible Equipment Make. Ditch Witch ; Brand. Ditch Witch ... New Parts Manual for Ditch Witch R65 Tractor Chassis This Ditch Witch model R65 Tractor Parts Manual Trencher Chassis Only is a reproduction of the original factoryissued Parts ManualIt shows 34 pages of ... Ditch Witch Plow Parts Manual A-DW-P-R65COMBO Buy Ditch Witch Plow Parts Manual A-DW-P-R65COMBO, Part #A-DW-P-R65COMBO at Tired Iron Tractor Parts, we're experts in tractor restoration and repair. Ditch Witch R-65 Vibratory Plow Attachment Parts Manual Our Parts Manuals contains exploded views of your entire tractor or machine with parts listings and part numbers. This manual will never let you order ... Ditch Witch R-65 Trencher Wisconsin Engine Service Manual Written in the language of a mechanic, this Service Manual for Ditch Witch provides detailed information on how to take your Trencher Wisconsin Engine apart, ... One New Operators & Parts Manual Fits Ditch Witch R-65 ... Buy One New Operators & Parts Manual Fits Ditch Witch R-65 Trencher Models Interchangeable with RAP70888: Spare & Replacement Parts - Amazon.com □ FREE ... New Parts Manual for Ditch Witch R-65 Tractor Chassis This Ditch Witch model R-65 Tractor Parts Manual (Trencher Chassis

Only) is a reproduction of the original factory-issued Parts Manual. Ditch Witch Chassis Parts Manual A-DW-P-R65 34 pages - Ditch Witch R-65 TRENCHER CHASSIS ONLY Parts Manual (PTS); Pages : 34. Sections and Models: Manuals > Manuals; Ditch Witch TRENCHER: R-65. Introduction to Radar Systems: Skolnik, Merrill Book details ; ISBN-10. 0072881380 ; ISBN-13. 978-0072881387 ; Edition. 3rd ; Publisher. McGraw-Hill Education ; Publication date. December 20, 2002. Introduction to Radar Systems Fundamentals of Radar Signal Processing, Third Edition. Mark Richards. 4.5 out of 5 stars 12. Hardcover. Introduction to Radar Systems - Skolnik, Merrill Introduction to Radar Systems by Skolnik, Merrill - ISBN 10: 0072881380 - ISBN 13: 9780072881387 - McGraw-Hill Education - 2002 - Hardcover. Where can I find a solution manual for Introduction ... Mar 2, 2015 — Where can I find a solution manual for Introduction to Radar Systems 3rd edition by Merrill I. Skolnik? Is there an ability to purchase one ... Introduction to Radar Systems by Skolnik, Merrill I. Skolnik, Merrill I. ; Title: Introduction to Radar Systems ; Publisher: Tata McGraw-Hill ; Binding: Soft cover ; Condition: Good ; Edition: 3rd Edition. Merrill Skolnik | Get Textbooks Radar Handbook, Third Edition by Merrill Skolnik Published 2008. ISBN-13: 978-1-299-95454-0, ISBN: 1-299-95454-5. Introduction to Radar Systems(3rd Edition) Introduction to - RADAR systems The third edition has been completely revised. It incorporates many of the advances made in radar in recent years and updates the basics of radar in a clear. Introduction to Radar Systems - Merrill I. Skolnik Since the publication of the second edition of Introduction to Radar Systems, there has been continual development of new radar capabilities and continual ... Radar Handbook.pdf He is the author of the popular McGraw-Hill textbook Introduction to Radar Systems, now in its third edition, the editor of Radar. Applications, as well as ... Introduction to Radar Systems by Merrill I. Skolnik, 3rd ... Introduction to Radar Systems by Merrill I. Skolnik, 3rd International Edition ; Item Number. 285437582198 ; Binding. SOFTCOVER ; International ISBN. 9780070445338. The Geography of You and Me by Jennifer E. Smith Apr 15, 2014 — Read 3652 reviews from the world's largest community for readers. Lucy and Owen meet somewhere between the tenth and eleventh floors of a ... The Geography of You and Me by Smith, Jennifer E. It's the tale of a boy and girl - total strangers - who meet in an elevator when the power goes out. After their power outage adventure, they both end up moving ... The Geography of You and Me Summary The Geography of You and Me (2014), a young adult contemporary romance novel by Jennifer E. Smith, follows what happens when two teenagers fall in love on ... The Geography of You and Me Smartly observed and wonderfully romantic, Jennifer E. Smith's new novel shows that the center of the world isn't necessarily a place. Sometimes, it can be a ... Book Review: The Geography Of You And Me - What's Hot Blog Apr 19, 2014 — The Geography of You and Me is a young adult romance novel by Jennifer E Smith. Can this young couple's long-distance relationship last? Review: The Geography of You and Me by Jennifer E. Smith Aug 9, 2016 — The Geography of You and Me by Jennifer E. Smith Genre: Contemporary, Romance Published by: Headline Pages: 337. Format: Paperback The Geography of You and Me by Jennifer E. Smith, ... Owen and Lucy meet when they get stuck in an elevator together. The power in New York City goes out and they spend an entire

night together, watching the stars. *The Geography of You and Me* by Jennifer E. Smith Aug 3, 2014 — Smith tells the story of two teenagers, Owen and Lucy. They lead very different lives and have very little in common apart from the apartment ... *The Geography of You and Me* Owen and Lucy meet when they get stuck in a New York City elevator during a widespread power outage. They quickly connect, spending an intimate (but chaste) ... *The Geography of You and Me* (Paperback) Mar 3, 2015 — "The Geography of You and Me is a magic, magic book. It will take you to a place where we all want to live, where true love overcomes any ...