

Table of Contents

Preface

Atomic Scale Mechanisms of Strengthening of Nitrogen Steels	
V.G. Gavriljuk	3
Atomic Interaction and Distribution of Nitrogen and Carbon Atoms in Binary Fe-N and Fe-C Alloys	
A. Sozinov, A.G. Balanyuk and V.G. Gavriljuk	13
Nitrogen Effect on Lattice Dynamics of FCC Fe-Cr-Mn (Ni) Austenitic Alloys	
S. Danilkin, A. Beskrovni and E. Jadrowski	19
Theoretical and Experimental Investigation of the Thermodynamic and Kinetic Nitrogen Absorption by Liquid Alloys	
G.M. Grigorenko, Y.M. Pomarin and V.Y. Orlovsky	25
The Neutron-Spectroscopy Proof of the Strong Cr-N Interactions in Nitrogen Stainless Steels	
V.V. Sumin, G. Chimid, T. Rashev and L. Saryivanov	31
Effect of Nitrogen Alloying on Elastic Coefficents of Austenitic Stainless Steel	
J. Tervo, A. Tarasenko and H. Hänninen	41
Distribution of Interstitial Impurities and their Diffusion Parameters in High-Nitrogen Steels Studied by Means of Internal Friction	
Y. Jagodzinski, S. Smouk, A. Tarasenko and H. Hänninen	47
Influence of the Flux Composition and State of the Gas Atmosphere over the Kinetics of Nitrogen Absorption by Steels and Alloys at the Arc Slag Remelting	
B.I. Medovar, L.B. Medovar, V.Y. Saenko, Y.M. Pomarin and A.V. Chernets	53
Phase Transformations in Iron-Nitrogen Martensites; Role of Elastic Strain Energies	
A. Böttger and E.J. Mittemeijer	61
Precipitates in Tempered Stainless Martensitic Steels Alloyed with Nitrogen, Carbon or Both	
V.G. Gavriljuk and H. Berns	71
Solubility of Nitrogen in Liquid Iron-Carbon Alloys	
A.G. Svjažin, V.E. Kindop and T. El Gammal	81
Modification of the Stainless Steel Database for High Manganese, Chromium and Nitrogen Contents	
J.A. Cotton, R.D. Knutsen and B. Sundman	89
Nitriding of Steel Powder-Thermodynamic Calculations and Experiments	
K. Frisk	95
Tempering of Iron-Carbon-Nitrogen Martensites: (Re) Distribution of Interstitial Atoms	
A. Böttger, P.J. Warren, G.D.W. Smith, M.J. van Genderen, S.J. Sijbrandij and E.J. Mittemeijer	103
Precipitation Sequences in Austenitic Fe-22Cr-21Ni-6Mo-(N) Stainless Steels	
S.J. Kim and T.H. Lee	109
Modeling Thermodynamics of Fe-N Phases: Characterisation of -Fe₂N_{1-z}	
M.I. Pekelharing, A. Böttger, M.A.J. Somers, M.P. Steenvoorden, A.M. van der Kraan and E.J. Mittemeijer	115
Thermodynamic Calculation of Stacking Fault Energy and its Effect on Fcc→Hcp Phase Transformation in Nitrogen Alloyed Stainless Steels	
I. Yakubtsov, A. Ariapour and D.D. Perovic	121
Equilibrium Constant and Nitrogen Activity and the Parameters of Interaction e_N^(N), r_N^(N), Mn^(N) in High Nitrogen Steels of Fe-Cr-Mn-N Type	
A.G. Svjažin, J. Siwka and T. Rashev	131
Effect of Nitrogen on the Response of Martensitic Stainless Steels to Rapid Heat Cycles	
W. Kaluba, R. Taillard and J. Focet	137
Precipitation in a High Nitrogen Superaustenitic Stainless Steel	
S. Heino, M. Knutson-Wedel and B. Karlsson	143
Current and Future Applications of High Nitrogen Steels	
G. Stein, I. Hucklenbroich and H. Feichtinger	151
High Nitrogen Martensitic Steel for Critical Components in Aviation	
I. Hucklenbroich, G. Stein, H. Chin, W. Trojahn and E. Streit	161

P 2000 - a New Austenitic High Nitrogen Steel for Power Generating Equipment	167
G. Stein, I. Hucklenbroich and M. Wagner	
New Industrial Applications of HNS	175
C.A.P. Rennhard	
Applications of Nitrogen-Alloyed Stainless Steels	181
J. Sundvall, J. Olsson and B. Holmberg	
Development of Commercial Nitrogen-Rich Stainless Steels	189
M. Liljas and J.O. Nilsson	
Investigation of Microstructure and Properties of a Chromium-Rich Austenitic Material with High Nitrogen Content	201
P.D. Portella, M. Köhler and M. Renner	
Effect of Structural Factors on the Mechanical Properties of High Nitrogen Austenitic Steels	209
N. Nakamura, T. Tsuchiyama and S. Takaki	
Principles of Alloy Design in High Nitrogen 12 % Chromium Steels	215
A. Göcmen, P. Ernst and P. Holmes	
Development of High Nitrogen Steels at Böhler Edelstahl GmbH Kapfenberg	227
J. Bernauer, G. Lichtenegger, G. Hochörtler and H. Lenger	
Solid State Alloying by Plasma Nitriding and Diffusion Annealing Treatment for Austenitic Stainless Steel	233
C.E. Pinedo, J. Vatavuk, S.D.d. Oliveira and A.P. Tschiptschin	
Properties of Cold Worked High Nitrogen Chromium-Based Alloys	241
H.J.C. Speidel, P.J. Uggowitzer, P. Ernst and M.O. Speidel	
Alloy Design for Suppressing Eutectoid Reaction in High Nitrogen Austenitic Steels	249
S. Takaki, N. Nakamura and H. Goto	
Chromium-Manganese Stainless Steels with Nitrogen Content up to 2.10 wt%	255
C. Andreev and T. Rashev	
Melting of High Nitrogen Steels	261
H. Feichtinger and G. Stein	
The Influence of Niobium and Vanadium on the Microstructure and Mechanical Properties of a High Nitrogen Stainless Steel	271
J.A. Cotton, R.D. Knutsen and C.I. Lang	
Influence of the Counter-Pressure Casting on the Macrostructure of High Nitrogen Steel Industrial Blocks	281
N. Andreev and T. Rashev	
Nitrogen Recovery from Mn Nitrides in Steel Melts	289
Y.E. Lee and R.J. Fruehan	
Gas Porosity Defects in Duplex Stainless Steel Castings	297
R. Arola, J. Wendt and E. Kivineva	
The Effect of Nitrogen Alloying on Stellite 21 Cobalt Chromium Molybdenum Biomedical Implant Alloy: Processing and Microstructure	303
W. Karlsen	
Interaction of Nitrogen with Dislocations Studied by Means of Amplitude-Dependent Internal Friction	309
Y. Jagodzinski, S. Smouk, A. Tarasenko and H. Hänninen	
Small-Angle Neutron Scattering in Austenitic Fe-18Cr-10Mn-16Ni-0.5N and Fe-21Cr-10Mn-17Ni-0.5C Steels	315
V.M. Nadutov, L.A. Bulavin and V.M. Garamus	
Mössbauer Effect and Neutron Scattering in Austenitic High Nitrogen Steel Fe-19Cr-19Mn-0.9N	321
V.M. Nadutov, V.M. Garamus and A.K. Islamov	
Strengthening of Nitrogen-Containing Maraging Steels	327
L.M. Kaputkina, V. Prokoshkina and D.Y. Uluntsev	
Mössbauer Surface Analysis of Nitrogen Ion Implanted Austenitic and Ferritic Steels	333
C. Cordier-Robert, A.M. Kliauga and J. Foct	
Simulation of the Crystallization and Structure of Ferro Alloys Containing Nitrogen	341
V. Manolov, A. Yotova, S. Bijev and T. Rashev	

Theoretical and Technological Principles of Controlling Properties in Nitrogen-Containing Structural Steels	
L.M. Panfilova, L.A. Smirnov and A.A. Filippennov	347
The Problems of High-Nitrogen Steels Production	
A.G. Sviažin, S.P. Efimenko and L.M. Kaputkina	353
HNS Steelmaking Process Using Thermal Plasma in a Ceramic Crucible	
J. Siwka, A.G. Sviažin, J. Jowsa and W. Derda	359
Investigation of the Non-Metallic Inclusions in a High Nitrogen Steel Block Cast by Counter-Pressure	
N. Andreev, T. Rashev and S. Popov	365
Refining of High Nitrogen Steels in a Closed Pressure Vessel	
W. Derda	371
The Gas Blow-Holes Forming in Nitrogen Iron Alloys and Steels during their Crystallization	
A.G. Sviažin, J. Siwka, Z. Skuza and A. Hutny	377
Nitrogen Control in AOD Converter	
P. Kupari and P. Hooli	385
High-Strength Single Crystals of Austenitic Stainless Steels with Nitrogen Content: Mechanisms of Deformation and Fracture	
Y.I. Chumlyakov, I.V. Kireeva, H. Sehitoglu, E.I. Litvinova, E.G. Zaharova and N.V. Luzginova	395
Anisotropy of Fracture Toughness of Austenitic High Nitrogen Chromium-Manganese Steel	
A.I. Balitskii, M. Diener, R. Magdowski, V.I. Pokhmurskii and M.O. Speidel	401
Dynamic Strain Aging of Austenitic High Nitrogen Cr-Ni and Cr-Mn Steels	
R. Ilola, M. Kemppainen and H. Hänninen	407
Mechanical Behaviour of Aged and not Prestrained High Nitrogen Austenitic Stainless Steels	
R. Taillard, F. Vandierschaeve and J. Focet	413
Effect of Cold Working and Aging on High Temperature Deformation of High Mn Stainless Steel	
M. Yoshikawa, R. Matsuki, Y. Habara and H. Aoyama	421
The Effect of Nitrogen on the Mechanical Behaviour of Cold-Worked Austenitic Stainless Steel Rod	
R.B. Dailly and A. Hendry	427
Nitrogen Alloyed 9-12% Chromium Steels with a Martensitic-Austenitic Microstructure	
U.E. Klotz, C. Solenthaler, P.J. Uggowitzer, M.O. Speidel and P. Ernst	437
Martensitic High Nitrogen Steel for Applications at Elevated Temperature	
H. Berns, C. Escher and W.-. Streich	443
Low Cycle Fatigue of High Nitrogen Austenitic Stainless Steel Single Crystals	
J. Chumlyakov, J.B. Vogt, E. Tchepel, J. Focet and I.V. Kireeva	449
Grain Boundary Strengthening in Austenitic Nitrogen Steels	
V.G. Gavriljuk, H. Berns, C. Escher, N.I. Glavatskaya, A. Sozinov and Y.N. Petrov	455
Study of Solid Solution Hardening Nature of Austenitic Steels with Various Nitrogen Content	
E. Kozlov, N. Koneva, A.V. Plevkov and T.V. Cherkasova	461
Investigation of Physical-Mechanical Properties and Structural Stability of the Nitrogen-Free and Nitrogen-Containing Austenitic Alloys of Fe-Cr-Mn System at Cryogenic Temperatures	
G.N. Grikurov, I.B. Baratashvili, N.P. Antropov, Y.I. Rusinovich and I.P. Galounenko	467
Corrosion Properties of HNS	
H. Hänninen	479
The Influence of Nitrogen Alloying on the Pitting and Crevice Corrosion of Austenitic and Duplex Stainless Steels	
R.F.A. Jargelius-Pettersson, J. Flyg and S. Wessman	489
Influence of Metallurgical and Chemical Variables on the Pitting Corrosion Behaviour of Nitrogen-Bearing Austenitic Stainless Steels	
U. Kamachi Mudali, S. Ningshen, A.K. Tyagi and R.K. Dayal	495
On the Crevice Corrosion Behaviour of Nitrogen Bearing Austenitic Stainless Steels	
A.A. Ono, T. Sinohara and S. Tsujikawa	503

The Influence of Tungsten (W) on Properties in High Nitrogen Stainless Steels	511
J.Y. Jonsson, L. Wegrelius, S. Heino, M. Liljas and R. Östberg	
Corrosion Behaviour of Solution Nitrided Stainless Steels	517
H. Berns, U. Eul, E. Heitz and R.L. Juse	
Influence of Hydrogen on Material Behaviour of High Nitrogen Austenitic Stainless Steel	523
M. Uhlemann, M.F. Shehata and K. Mummert	
Pitting and Intergranular Corrosion Resistances of Nitrogen Ion Implanted Type 304 Stainless Steel	531
U. Kamachi Mudali, T. Sundararajan, K.G.M. Nair and R.K. Dayal	
Long Term Strength of High Nitrogen Steels in Water and Chloride Solutions	539
A.I. Balitskii	
Stress Corrosion Cracking Susceptibility of Nitrogen Alloyed Stainless Steels in 50% CaCl₂ Solution	545
H. Leinonen and H. Hänninen	
Effect of Nitrogen Ion Implantation on the Corrosion Resistance of Titanium Modified Type 316L Stainless Steel in Comparison with Argon and Oxygen Ion Implantation	553
T. Sundararajan, U. Kamachi Mudali, K.G.M. Nair and M. Subbaiyan	
Improvements in Localized Corrosion Resistance of Nitrogen Ion Implanted Type 316L Stainless Steel Orthopaedic Implant Devices	561
K.M. Veerabadrani, U. Kamachi Mudali, K.G.M. Nair and M. Subbaiyan	
Nitrogen Bearing Austenitic Stainless Steels for Surgical Implants	569
A.P. Tschiptschin, C.H. Aidar, F.B. Neto and N. Alonso-Falleiros	
An Experimental and Theoretical Study of Nitrogen Flux in Stainless Steel TIG Welds	579
S. Hertzman and S. Wessman	
Recent Developments on the Weldability of a New High Nitrogen Stainless Steel	591
M. Harzenmoser, C. Rennhard, M. Hereth and M. Diener	
Welding of High Nitrogen Superaustenitic and Superduplex Stainless Steels	597
V. Gross, H. Heuser and T. Ladwein	
The Role of Nitrogen in Improving Pitting Corrosion Resistance of High-Alloy Austenitic and Duplex Stainless Steel Welds	603
M. Vilpas and H. Hänninen	
Comparison of Welding Behaviour of SUS316L Steel by Gas Tungsten and Gas Metal Arc Processes in High Pressure Nitrogen Atmosphere	609
O. Kamiya and Y. Kikuchi	
The Effect of Hydrogen and Cooling Rate on the Mechanical and Corrosion Properties of SAF 2507 Duplex Stainless Steel Welds	615
J.D. Kordatos, G. Fourlaris and G. Papadimitriou	
Mechanical Characteristics of High Nitrogen Contained Weld Metal Based on 316L Stainless Steel	621
Y. Kikuchi, O. Kamiya and H. Kobayashi	
Powder Metallurgically Produced High Nitrogen Steels	629
J. Liimatainen	
High Nitrogen Corrosion Resistant Austenitic Stainless Steels Produced by HIP P/M Processing	635
G.O. Rhodes and W.B. Eisen	
Powder Metallurgy High Nitrogen Stainless Steel	649
F.S. Biancaniello, R.D. Jiggetts, R.E. Ricker and S.D. Ridder	
Nitrogen Alloying of Steel Powder Using Ammonia Gas in the Fluidised Bed	655
J. Virta and S.P. Hannula	
Nickel-Free High Nitrogen Austenitic Stainless Steels Produced by Metal Injection Moulding	663
P.J. Uggowitzer, W.-. Bähre, H. Wohlfommm and M.O. Speidel	
Effect of Nitrogen Content on Precipitation during Isothermal Annealing of P/M High Nitrogen Austenitic Stainless Steels	673
J. Romu and H. Hänninen	
Mechanical Properties and Corrosion Resistance of PM High Nitrogen Stainless Steel Consolidated by Hot Extrusion	681
T. Isomoto, H. Ikeda, T. Kouda, K. Ichii and T. Oishi	

Amorphization and Nanoscale Refinement of High Nitrogen Containing Fe-Based Crystalline Materials by Mechanical Alloying	687
H. Ogawa, K. Omuro and H. Miura	
Nitrogen Addition to bcc-Fe by Attrition Milling	695
J. Rawers, R. Krabbe and D.C. Cook	
Hot-Press Compaction of High Nitrogen Containing Austenitic Stainless Steel Powders Mechanically Aligned	701
K. Omuro, H. Miura and H. Ogawa	
Preparation of High Nitrogen Cr-Ni and Cr-Mn Stainless Steel Powders by Mechanical Alloying and their Compositional Dependence of Austenitizing	707
H. Miura, H. Ogawa and K. Omuro	
Mössbauer and Small-Angle Neutron Scattering Study of Fe-Powder Mechanically Aligned in Nitrogen and Argon Gas Environment	715
V.M. Nadutov, V.M. Garamus and J. Rawers	
Metallurgy of Nitrogen Absorption Process in High Cr Steels	723
S. Takaki and N. Nakamura	
Micromechanisms of Fatigue in High Nitrogen Duplex Steels	733
O.B. Pedersen	
Wear Properties of HNS	743
J. Tervo	
Microstructural Stability and Mechanical Properties of a High Nitrogen Super Duplex Stainless Steel	751
J.O. Nilsson, P. Kangas, T. Karlsson and A. Wilson	
Characterization of Fe-C/N Steel	757
J. Rawers and P.J. Uggowitzer	
Shape Memory Training and Properties of Fe-Mn-Based High Nitrogen Steels	763
O. Söderberg, P. Yakovenko, K. Ullakko, V.G. Gavriljuk and V.K. Lindroos	
Nitrogen Content and Orientation and Their Relation to Slip Activity, Twinning and Crack Formation during Cold Rolling of Austenitic Single Crystals	769
N. Akdut, J. Keichel and J. Focet	
The Hot Workability of CromaniteTM, a High Nitrogen Austenitic Stainless Steel	777
J.N. Tarboton, L.M. Matthews, A. Sutcliffe, C.M.P. Frost and J.P. Wessels	
Recrystallisation in High Nitrogen Aligned Super Duplex Stainless Steel	785
J. Keichel, G. Gottstein and J. Focet	
Diagrams of Dynamic Recrystallization of Austenitic Stainless Steels with Nitrogen	793
L.M. Kaputkina, S.P. Efimenko, S.V. Dobatkin, E.M. Leschinskaya, V.M. Panovko and M.A. Kazakov	
Effect of Structure - Texture Evolution on Cold Work Hardening Caused by Rolling of Nitrogen Cr-Ni-Mn Austenitic Steels	799
N.I. Glavatskaya	
A Comparative Study of the Mechanical, Magnetic and Microstructural Characteristics of Modified SAF 2205 and 2507 Type Duplex Austenitic-Ferritic Stainless Steel	805
G. Fourlaris, M.G. Maylin and T. Gladman	
Low Cycle Fatigue of High Nitrogen Duplex Stainless Steels	811
J.B. Vogt, K. Massol and J. Focet	
Structural Evolution of a 2205 Duplex Stainless Steel between 500°C and 800°C and Pitting Corrosion Resistance	817
J.D. Kordatos, G. Fourlaris and G. Papadimitriou	
Magnetic Domain Imaging and Mechanical/Magnetic Property Characterisation of a 2507 Type Duplex Austenitic-Ferritic Stainless Steel	823
G. Fourlaris, M.G. Maylin and T. Gladman	
Quantitative Assessment of Intermetallic Phase Precipitation in a Super Duplex Stainless Steel Weld Metal Using Automatic Image Analysis	829
A. Gregori, J.O. Nilsson and F. Bonollo	
Structure and Properties of Chromium Nickel Dual Phase Nitrogen Steel after Solidification, Plastic Working and Heat Treatment	835
L.M. Kaputkina, V. Prokoshkina, A.G. Svjažin, J. Siwka, D.Y. Uluntsev and V.E. Kindop	