

The 8th International Congress on Heat Treatment of Materials

Heat & Surface '92

Edited by Imao Tamura

The International Federation of Heat Treatment and Surface Engineering

The Japan Society for Heat Treatment

Research Institute for Applied Sciences

Contents

**Opening Lectures**

1. Duplex Surface Engineering  
T. Bell, Y. Sun ..... 1
2. Advanced Performance of Steel Surfaces Modified by Carburizing  
G. Krauss ..... 7
3. Recent Status of Heat Treatment Technology in Japan  
I. Tamura ..... 13

**Microstructure of Steels**

1. Keynote Lecture the Microstructure as a Time-Temperature Recorder-  
Remaining Life Prediction  
H. K. D. H. Bhadeshia ..... 19
2. Effects of Alloying Elements and Microstructure on the Stability of  
Retained Austenite in Low-Alloy TRIP Steels  
N. Imai, N. Komatsubara, K. Kunishige ..... 25
3. Forming of Microstructure and Mesohardness in Subsurface Layer of  
Cylindrical Gears  
Tadeusz Zaborowski ..... 29

4.	Effects of TMCP Processing Conditions on Microstructural Modification in 600MPa Class Structural Steel for Building Application S. W. Lee, W. Y. Choo	33
5.	Effect of Cooling Rate on Spheroidized Cementite Structure in Annealing of Medium Carbon Steel T. Ochi and Y. Koyasu, T. Mori	37
6.	Relationships Between the Various Constituents Formed in the Homogenized Austenite by Noncontinuous Cooling Sun Fushen, Sha Jianduo, Li Gingbo	41
7.	Effect of Intercortical Quenching and Tempering on Microstructure of 590MPa Tensile Strength Class Steel Plate with Low Yield Ratio T. Koseki, K. Uchida, K. Amano	45
8.	Effect of Alloying Elements on Microstructure and Mechanical Properties of Low-Carbon Bainitic Steels N. Iwama, K. Tsuzaki, T. Maki	49
9.	Review of Development and Application of Micro alloyed Engineering Steels in China Guifen Li, Qi Wang, Han Dong	53
10.	The Influence of Heat Treatment on Magnetic Properties of Martensitic Stainless Steels M. Ando	57
11.	Heat Treatment of Soft Magnetic Stainless Steel for Solenoid Valve T. Usami, Y. Honkura	61

#### Transformation of Steels

1.	Influence of Vanadium on Austenite Recrystallization Behavior of Micro alloyed Steel in Thermomechanical Processing
----	--

	T. Katoh, I. Nomura, Y. Hanai, T. Yamamoto	65
2.	Influence of the Previous Austenitic Grain Size on the Transition Temperature of a 0.2%C Carbon-Steel Alberto A. Raslan, Carlos A. Bottrel-Coutinho	69
3.	Isothermal Transformation Kinetics in Carbon Steel J. G. Cabafias-Moreno, F. Medina, M. Gonzalez, J. E. Araujo-Osorio, M. Umemoto	73
4.	Mathematical Model of Dynamic Recrystallization A. V. Kaptan, Yu. N. Gornostyrev, V.N. Urtsev, V. I. Levit	77
5.	Effect of Magnetic Fields on Isothermal Martensitic Transformation in an Fe-Ni-Mn Alloy T. Kakeshita, K. Kuroiwa, K. Shimizu, T. Ikeda, M. Date	81
6.	$\gamma/\alpha$ Transformation and NbC Precipitation in Nb Containing Steels J. K. Lee, K. J. Lee, K. B. Kang, O. Kwon	85
7.	Microstructure and Mechanical Properties of the Ferritic Phase Obtained from Isothermal Austenite to Ferrite Transformation of 9Cr1 Mo Steels with N, V and Nb Additions J. C. Brachet	89
8.	Analysis and Interpretation of the Splitting Phenomena Occurring in Martensitic Transformation of Stainless Steels X45Cr13 and X45CrMoV14 C. Garcia, L. F. Alvarez	93
9.	Carbides Growth Behavior of a Ball Bearing Steel During Repetitive Heat-Treatment Y Okada	97
10.	Effects of Heat Treatments and Alloy Elements on Boron Behavior in High Alloy Steels H. Tanaka, K. Shibata	101

11.	The Partitioning of Manganese & Nitrogen in Dual Phase Steels L. A. Erasmus, R. Ratnaraj	105
12.	The Effect of a Planar Interface in Biomaterials on the Solubility Enhancement in the Presence of Inclusions H. Y. Yu, S. C. Sanday	109
13.	Effect of Hardening Condition on Quench Distortion of 1 %C-1.4% Cr Steel Y Mikita, I. Nakabayashi	113
14.	A Comparative Study on the Cooling Curves with JIS Silver Specimen and Alloy 600 Specimen in Relation to Additive Effectiveness I. Tamura, N. Shimizu, S. Ando S. Asada	117
15.	Tempering Processes of Fe-C-N Martensite Shiren Chen, Shuiyuan Dai	121
16.	Extended Nb(C,N) Precipitation Model Applicable to Extra Low Carbon Steel S. Akamatsu, T. Senuma, M. Hasebe	125
17.	Study of Tempering Process of Au forming Martensite in 4Cr5MoVSi Steel Gao Shouyi, Zhang Liwen, Guo Chao, Zhao Zhiguo, Gao Feng	129

### **Properties of Steels**

1.	Keynote Lecture Thermo-Mechano-Chemical Treatment (TMCT) of Steels T. C. Lei, X. Y. An, Z. R. Liu	133
2.	Effect of Grain Boundary "MA" Phase on Toughness in the Intercortical Zone of a HSLA Steel C. L. Davis, J. E. King	139
3.	The Formation of Lower Bainitic Carbide Hong-Sheng Fang, Jia-Jun Wang, Yan-Kong Zheng	

	.....	143
4. Microstructure vs Mechanical Properties in Low Carbon Martensite Steels for Application to Automobile Parts M. Takenaka, Y. Tomota, H. Kuratomi , I. Tanimoto	.....	147
5. Embrittlement and Crack Propagation Behavior in Precipitation-Hardened Stainless Steel at Intermediate Temperature T. Mori, K. Take, S. Tanaka, H. Ono,,S. Minakata	.....	151
6. Effect of Coolant's Peculiarity on Quench Cracking of 1 %C-1.4%Cr Steel Y Mikita, I. Nakabayashi	.....	155
7. The Present Status and Future of Hardness Standards Particularly Rockwell Hardness H. Yamamoto, T. Yamamoto	.....	159
8. Development of High Strength Steel Wire for Prestressed Concrete Use by a Warm Drawing Technique T. Shiraga, T. Sampei, H. Osuzu	.....	163
9. Quench Crack of Steel — Its Occurrence and Prevention— S. Owaku	.....	167
10. Damping and Mechanical Properties as Functions of Martensite Fraction and Heat Treatment in an Fe-Cr-Al Damping Alloy Liu Xiaodong, Wu Baorong	.....	171
11. The Influence of Heat Treatment Condition on the Properties of a Matrix High Speed Steel Y. Tamura	.....	175
12. Evaluation of Embrittlement of Precipitation Hardened Stainless Steels with Reflection-type Scanning Acoustic Microscope A. Kodai, T. Mori, S. Tanaka, H. Ono, S. Minakata	.....	179

13.	Effect of Carbon Content on Delayed Fracture of High Strength Bainitic Sheet Steel K. Fukui, T. Kaneko	183
14.	Effect of Al Content on Mechanical Property of Cold-Rolled Sheet Steel with Retained Austenite N Mizui	187
15.	Effects of Heat Treatment Condition Against Denting on High Strength Bearing Steel K. Toda, T. Mikami	191
16.	Heat-Treatments, Mechanical Properties and Machinability of Tri-Phase Steel Composed of Ferrite, Martensite and Graphite H. Sueyoshi, Y. Nakamura, R. Tanaka	195

#### **Cast Iron and Non-Ferrous Alloys**

1.	Influence of Carbon Equivalent on the Transformation of Non-Alloyed Ductile Irons During Austempering Rositsa Ivanova, Elena Christova	199
2.	Mechanical Properties of Austempered Ductile Iron Toughened by Special Heat Treatment S. Yamada, T. Kobayashi, K. Matsuo	203
3.	Characteristics of Laser Heat Treated Ductile Cast Irons H. Matsuyama, K. Shibata	207
4.	Microstructure of Ni Alloys Produced by Carbide Dispersion Carburizing S. Kamada, Y. Kawabe, M. Watanabe, A. Nagata	211
5.	Microstructure and its Development in Mn-Ni-Al Bronze Propeller Alloy J. Hallen-Lopez, J. L. Estrada, J. I. Dickson, M. Sahoo	215

6.	The Effect of Sn on the Age-Hardening of A1-1.1Mg2Si-0.3Cr Alloy M. Yanagawa, K. Matsumoto, S. Oie	219
7.	Improvement of Creep-Rupture Properties Owing to Control of Microstructures by Heat Treatment in High-Tungsten and Low-Carbon Cobalt-base Superalloys: M. Tanaka	223
8.	The Role of Additional Elements on the Suppression of Cellular Precipitation in Cu-Base Alloys M. Mild, Y. Ogino	227
9.	Microstructure Control for High Strain-Rate Super plasticity in Aluminum-Based Alloys K. Higashi, T. Mukai, S. Tanimura, A. Inoue, T. Masumoto, K. Ohtera	231

### **Advanced Materials**

1.	Keynote Lecture Heat Treatment and Microstructure of Partially Stabilized Zirconia T. Sakuma	235
2.	Isothermal Transformation Behaviors of Martensite in Y-PSZ with and without Alumina Addition: H. Tsubakino, K. Sonoda, T. Fujiwara, R. Nozato	241
3.	Tetragonal-to-Monoclinic Phase Transformation in a ZrO <sub>2</sub> -2mol%Y <sub>2</sub> O <sub>3</sub> Alloy Y Zhou, Y J. Tang, T. C. Lei	245
4.	Grain Growth Inhibition in High- Purity Alumina by Zirconia Particles K. Okada, T. Sakuma	249
5.	Heat Treatment of High-Tc Superconductor by Infrared-Ray Irradiation M. Akinaga, T. Endo	253
6.	Protective Surface Layer Formed on Carbon-Based	

	Composites for High Temperature Oxidation K. Kobayashi, K. Maeda, H. Sano, Y. Uchiyama	257
7.	Thermomechanical Heat Treatment for Grain Refinement in Superplastic Aluminum-Based Composites with Si <sub>3</sub> N <sub>4</sub> M. Mabuchi, K. Higashi	261
8.	Oxidation Characteristics of Composite Ni <sub>3</sub> Al-Mo at High Temperature <i>C. G. Wang, Q. F. Peng, S. M. Kikuchi</i>	265
9.	Grain Boundary Topology in Mechanically Alloyed MA 6000 <i>K. Murakami, H. Harada, H. K. D. H. Bhadeshia</i>	269
10.	Structure and Properties of Fe-Cr-N Powdered Alloys Prepared by Mechanical Alloying <i>Y Ogino, T. Yamasaki</i>	273
11.	Recrystallization of Ferritic Materials Obtained by Mechanical Alloying <i>A. Alamo, H. Regle, J. L. Bechade</i>	277
12.	Formation and Characterization of Sintered Ultrafine-Particles <i>M. Udaka, K. Kawasaki, T. Yamazaki, M. Umemoto, I. Okane</i>	281
13.	Atmosphere Role on Binder Degradation During Heat Treatment of Injection Molded Steels E. <i>Streicher, M. Renowden, M. Phillips, R. M. German, J. M. Friedt</i>	285
14.	The Influence of Heat Treatment on Cutting Performance of P/M High Speed Steel Tools <i>J. Nishida, N. Uchida</i>	289
15.	Laser Rapid Solidification of Alloys <i>S. Katayama, A. Matsunawa</i>	293

16.	Aging Behavior and Tensile Properties of SiC/6061 Composites Produced by PLF Process <i>Y Tomota, M. Huang, H. Ohta, Y. Takeuchi</i>	297
17.	Phase Transformation in Ti-6Al-4V and Ti-10V-2Fe-3Al Alloys During Isothermal Aging <i>H. Tsubakino, M. Takeda, R. Nozato, K. Nakase</i>	301
18.	Mechanical Alloying in the Al-Ni-Ti System <i>T. Itsukaichi, T. Norimatsu, Bing-Yao Wu, M. Umemoto, I. Okane</i>	305
19.	Magnetic Properties of Rare Earth- Iron-Nitrogen Compounds Prepared by Mechanical Alloying <i>T. Itsukaichi, K. Iga, M. Hosokawa, M. Umemoto, I. Okane</i>	309
20.	Effects of Heat Treatment on Compositional Changes of Amorphous Si-N-C Fine Powders with Y <sub>2</sub> O <sub>3</sub> and Al <sub>2</sub> O <sub>3</sub> <i>T. Amano, K. Sasaki, T. Hirai, K. Izaki</i>	313

### **Carburizing and Nitriding**

1.	Keynote Lecture Development of Diffusion Coating in Japan and its Tendency in the Future <i>S. Ueda</i>	317
2.	The Microstructure and Properties of Combined Penetration in Copper <i>Pang Zhaofu, Wang Shuhui</i>	321
3.	The Defect Structure of Mechanically Alloyed Iron <i>V G. Kurdjumov, S. V. Ovanesov</i>	325
4.	Formation of B-Fe Interfused Layers on Steel Substrate During Dynamic Mixing Using B Ion Implantation and Ti Evaporation <i>T. Yasunaga, Y. Sugizaki, H. Satoh</i>	329
5.	Hard Coating by Plasma Enhanced CVD on Pre-nitrided Low Alloyed Steel <i>H. J. Spies, K. Hoeck, B. Larisch</i>	

	.....	333
6. Behaviors of TiN and Ti-TiN Coatings on Steels by HCD Process <i>Hon-Sho Chung, Yinsheng Shueh, Ray-Kwan You</i>	.....	337
7. Duplex Surface Treatment of Aluminum Alloys <i>F. Ashrafizadeh</i>	.....	341
8. Thermo-Mechanical Simulation of Ceramic Coating Process <i>T. Inoue, T. Hoshide, K. Kumagai</i>	.....	345
9. Carbide Formation and Counter-Transformation Behaviors in the Deep-Carburization Process <i>J. Z. Chen, L. Shu, J. G. Yong</i>	.....	349
10. Effect of Nitrogen Addition on Microstructures and Fatigue Behaviors of Carburized Case in M50NiL Steel <i>Chenqin Gu, Xiaotian Jing, Bingzhe Lou, Fusan Shen</i>	.....	353
11. Impact Fatigue and Fatigue Characteristics of Carburized SCM415 Steels <i>T. Kobayashi, M. Niinomi, K. Uwai, S. Adachi</i>	.....	357
12. High Tough and High Fatigue Strength Carburizing Steel <i>K. Namiki, A. Hatano</i>	.....	361
13. Application of Nitriding for Dies and Tools <i>Y Fujita, H. Kouka, M. Takei</i>	.....	365
14. Pitting Strength of Spur Gear (Influence of Surface Treatments and Lubricating Oils on Pitting Strength of Spur Gears) <i>C. Naruse, R. Nemoto, S. Haizuka</i>	.....	369
15. Decades of Advancement in Surface Heat-Treatment of Automotive Components <i>K. Funatani</i>	.....	373

16.	Effects of Alloying Elements on Gas Nitriding Properties <i>K. Kobayashi, K. Hosoda, K. Tsubota</i>	..... 377
17.	Effect of a Plated 18Cr-8Ni Stainless Steel for an Acceleration of Nitrogen Diffusion in Fcc Ferrous Alloy <i>K. Gemma, M. Kawakami, H. Ueda, N. Tokuhara, A. Kanayama, H. Kasahara</i>	..... 381
18.	Mechanical Characteristics of Ion-Nitrided Sintered Steels Alloy Elements Influence <i>B. Tesi, A. Molinari, A. Tiziani, T. Bacci</i>	..... 385
19.	The Research of Pure Iron Reheated Transformation after Ion-Nitriding Furnace-Cooling <i>Zhang Jin, Zhou Shangqi, Hu Zhenji</i>	..... 389
20.	Sulphonitriding of Iron and Steel by Use of a Fluidized Bed <i>I. Cheong, A. Ikenaga, M. Kawamoto, T. Sone, N. Hamasaka</i>	..... 393
21.	Relationship Between Corrosion Properties and Microstructure of Oxynitrided Steels <i>J. Mongis, JP. Peyre, D. Duchateau, H. Michel, C. Leroy, T. Konkoly</i>	..... 397
22.	Nitrocarburizing Plus Post Oxidation - an Economical Surface Engineering Process for a Wide Range of Applications <i>Georg Wahl</i>	..... 401
23.	Vacuum Carburizing of Steels Parts in an Industrial Oil Quenching Vacuum Furnace <i>P. Jacquot, S. Deshayes, E. Denisse, JP. Souchard, G.Dervieux</i>	..... 405
24.	The Effects of Retained Austenite on the Fatigue Properties of Carburized Steels <i>A. Inada, H. Yaguchi, T. Inoue</i>	..... 409

## **Induction and Laser Heat Treatment**

1.	Structure Transformation and Processes of Surface Strengthening Due to	
----	--	--

Plasma-Arc Treatment of Structural Steels <i>D. S. Stavrev, L. M. Kaputkina, S. K. Kirov, Gu. V. Shamonin, V. G. Prokoshkina</i>	413
2. Induction Hardening of Gears by Dual Frequency Induction Heating <i>Y Matsubara, M. Kumagawa, Y. Watanabe</i>	417
3. Microalloyed Steel Strengthening Mechanisms and its Characteristics of Surface Heat Treatment <i>Xuefang Li, Changsheng Ai</i>	421
4. Laser Transformation Hardening of AISI 01 Tool Steel <i>L. J. Yang, S. Jana, S. C. Tam, Lennie E. N. Lim</i>	425
5. Selective Surface Treatment of Gears by Induction Profile Hardening <i>G. D. Pfaffmann</i>	429
6. Laser Surface Melting of a Cr-Ni-Mo Cast Iron A Microstructural Study <i>M. O. Baptista, A. P. Loureiro, R. Vilar</i>	433
7. Microstructure and Wear Properties of Laser Clad Cold Drawing Plugs <i>Kezhi Wang, Junhe Lu, Yongxue Yang, Shun Yuan, Shigui Xie, Weijing Zhang</i>	437
8. "Hard Eye" Ductile Cast Iron and Its Treatment by Laser Quenching <i>M. Tsujikawa, M. Hino, M. Kawamoto, K. Okabayashi</i>	441
9. Effects of Alloying Elements and Heat Treatments on Induction-hardenability of 0.53%C Steel <i>T. Hoshino, K. Amano, N. Tabata, S. Nakano</i>	445

### **Atmosphere Control**

1. Keynote Lecture Heat Treating Furnace Technology Present Status and Challenges <i>T Banno</i>	449
---	-----

2.	Negative-Pressure & Self-Cleaning Type Vacuum Carburizing Furnace and the Self-Cleaning Method <i>Zhang Jianguo, Tian Tong</i>	455
3.	A Gas Sensor System for Simultaneous Determination of Partial Pressures of CO and CO <sub>2</sub> <i>Xuyun Ye, Enhui Liu, Pingjian Li</i>	459
4.	Energy-Savings and Anti-O <sub>2</sub> Measures for Atmosphere Heat Treatment — Energy and Environmental Safeguards — <i>N. Kanetake</i>	463
5.	Gas Utilization Technique in Heat Treatment Furnace <i>H. Fujiwara</i>	467
6.	Automatic Control of Nitrogen-Hydrocarbon Gas Atmosphere by Carbon Flux <i>H. Ishiguro, E Rotman, P. Baldo, M. Robert</i>	471
7.	Drip Feed Rate Display and Control Device for Chemical Heat Treatment <i>ChangSheng Ai, GuoJing Huang</i>	475
8.	Atmosphere Control of Heat Treatment Furnace Using O <sub>2</sub> Sensor Current Standing and the Future <i>Herbert W. Bond, K. Ota</i>	479
9.	Coatings Transformation of Aluminide Intermetallic Coatings on Single Crystal Nickel-Base Superalloys During Heat Treatment and Subsequent Exposure <i>W. F. Gale, T. C. Totemeier, J. E. King</i>	483
10.	Rapid Thermochemical Treatment (Salt Bath Nitriding / Vacuum Carburizing) <i>T. Sato, K. Hoshino, T. Kurosawa, H. Abe</i>	487
11.	Intermetallic Matrix Composite Coatings by Means of RF Plasma Spraying	

	<i>M. Fukumoto, M. I. Boulos</i>	491
12.	Coatings on Iron by LPCVD of SiH <sub>4</sub> <i>A. N. Liyanage, M. Kimura, E. Ozawa, J. M. Friedt</i>	495
13.	Effect of Heat Treatment on the TiN Coating Films Ion-Plated on SK5 <i>Y Uchiyama, M. Hasaka, K. Kobayashi</i>	499
14.	Low Temperature Salt Bath Coating of Chromium Carbonitride <i>Y Ohta, Y. Sugimoto, T. Arai</i>	503
15.	Fluidized Bed Carbide Coating Process Development and its Application— <i>K. Nakanishi, H. Takeda, H. Tachikawa, T. Arai</i>	507
16.	A Study on Surface Modification of Aluminide Coatings by Yttrium Ion Plating <i>Woon Suk Hwang, Hee Sik Sohn, Kyoo Young Kim, Sun Hyo Kim</i>	511
17.	Carbides Coating with Cr and Ti on Steel Surface <i>K. Yoshida, N. Takishima, K. Mizumura, Y. Sato</i>	515
18.	Plasma Super Carburizing Characteristics and Fatigue Properties of Chromium Bearing Steels <i>T. Kimura, K. Namiki</i>	519
19.	Friction and Wear of Nitrided JIS SKD61 Under Severe Dry Sliding <i>Shih-Chin Lee, Li-Hui Chen, Min-Han Yeh</i>	523
20.	Microstructure of Plasma Nitrided Layers in Ti-20V Alloy <i>J. Kondo, H. Kuwahara, S. Kikuchi</i>	527
21.	High-Pressure Nitriding of Titanium Materials <i>F. Preif3er, P.Minarski, F. Hoffmann, P. Mayr</i>	531

22.	Surface Characterization of Plasma Nitrided Titanium Alloys <i>M. Salehi, T. Bell</i>	535
23.	Heat Treatment Effect on Ion-Nitrided Coatings in $\alpha$ -Ti Titanium Alloys <i>B. Tesi, T. Bacci, G. Pradelli, C. Gianoglio</i>	539
24.	On Wear and Corrosion Resistant PVD CrN Coatings <i>O. Knotek, F. Loffler, H. J. Scholl, A. Schrey</i>	543
25.	The Influence of Nitrided Phases on Structure and Wear Resistance of Duplex PVD TiN/Plasma Nitrided SKD61 Steel <i>Sung-Mao Chiu, Cheng-Tao Wu</i>	547

### **Computer Modelling**

1.	Keynote Lecture State of the Art of Computer Simulation in Quenching <i>Bozidar Liscic</i>	551
2.	Superior Heat Treatment Mastering Gas-Metal Interactions and Using Computer Modelling <i>F. Rotman, E. Duchateau, H. Ishiguro</i>	554
3.	Benchmark Testing of Computer Programs for Determination of Hardening Performance <i>Jan Bodin, Soren Segerberg</i>	557
4.	Establishment of Nitrogen Concentration Profile Models of Alternative Current Ion Nitriding <i>Yan Mufu, Zu Guocheng, Xia Lifang</i>	561
5.	Theory and Implementation of Heat Treatment Simulation Program "HEARTS" <i>T. Inoue, K. Arimoto, D. Y. Ju</i>	565
6.	Computer Simulation of Microstructural Evolution in Cr-Mo	

Steels during Heat Treatment <i>Y. Saito, A. Matsuzaki, C. Shiga</i>	573
7. Heat Transfer Modelling and Use of Helium in Order to Improve Vacuum Quenching <i>B. Lhote, H. Takahashi, M. Phillips, O. Delcourt, R.Speri</i>	577
8. Production Management Systems Using Personal Computers for Heat Treating Facilities <i>A. Takeuchi</i>	581
9. The Application of the Mathematical Method in Heat-Treatment Practice <i>Chen Sheng, Zhu Dunlun</i>	585
10. FEAHT a PC-based Package for Solving Coupled Problems on Induction Heat Treatments <i>G. Maizza, M. Kitajima, B. De Benedetti</i>	589
11. Research of the Influence of the Texture-Structure Parameters of the Surface on Crack Resistance of Metal <i>V.N. Urtsev, V. A. Maslennikov, V. P. Gubtchevsky, D. M. Zlatoustovsry, A. V. Kaptan</i>	593
12. Computer Simulation for Heat Treatment of Gears <i>H. Shichino, Y. Nagasaka, T. Takahashi, S. Kiguchi, N. Hamasaka</i>	597
13. Determination of Optimal Heating Time with Computer Aid <i>Huo Jin-San, Wang Xue-Chian</i>	601

### Heat Treating Equipment

1. Hot Wall Type Vacuum Carburizing Furnaces <i>T. Seki</i>	605
2. Fluidised Bed Furnaces for the Heat Treatment of Metals - A Review of	

Development and Application <i>R. W. Reynoldson</i>	609
3. Development of an Induction Heating Furnace for Heat Treatment in a Fluidized Bed <i>V. Leskovsek, T. Kolenko, A. Paulin</i>	613
4. The Infrared Halogen Heat Sources and Applications for the Heat Treatment of Metals <i>T. Konkoly</i>	617
5. HIP Quencher for Efficient and Uniform Quenching <i>C. Bergman, S. Segerberg</i>	621
6. Heat Treating Furnace Systems with Integrated Single-Part Press Quenching <i>D. Grassl</i>	625