1. Effect of preliminary heat treatment on the microstructure evolution and fatigue strength of ion nitriding 42CrMo steel (*Open Access*)

Yin, Chaochao (1); Chen, Zhi (1); Chu, Ruijuan (2); Wei, Chaozhang (1); Shi, Lubing (1); Lu, Jinsheng (1); Pei, Bang (1); Wang, Wei (1); Liu, Zhongming (1)
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Abstract: Preliminary heat treatment is a key process during gear nitriding, directly affecting microstructure, strength and toughness. In order to further improve fatigue strength of nitriding gears, the paper investigates the microstructure evolution of ion nitriding 42CrMo steel under different preliminary heat treatments, i.e., polyalkylene glycol (PAG) quenching + tempering (PT), oil quenching + tempering (OT), 280 °C salt bath quenching + tempering (ST) and normalizing + tempering (NT). The fatigue testing is conducted via the self-developed rolling contact fatigue testing machine. The microstructure characteristics of nitriding layer and core material were systematically investigated by electron backscatter diffraction (EBSD), scanning electron microscope (SEM), XRD, impact testing machine and etc. The experimental results indicate that the average rolling contact fatigue life of the sample PT is the longest, followed by sample OT, sample ST, and sample NT, which are 3.30 × 106 cycles, 2.88 × 106 cycles, 2.02 × 106 cycles and 1.77 × 106 cycles, respectively. The heat treatment methods of 42CrMo steel produce different microstructures, grain sizes, and dislocation degrees, affecting the fatigue strength. The XRD test results indicate that PT sample has the best effect on fine grain strengthening and dislocation strengthening. The EBSD test results indicate that the proportion of HAGBs in the PT sample is the highest, reaching 57.6 %, and the least in the NT sample, which is 47.7 %. The impact energy at −20 °C in the PT sample is the highest, reaching 55.3 J, and the least in the NT sample, which is only 2.7 J. This study reveals the mechanism of preliminary heat treatment on the fatigue strength of ion nitriding 42CrMo steel, providing a theoretical basis for further improving fatigue strength. © 2025 The Authors. (28 refs)
Main heading: Coremaking
Controlled terms: Aluminum nitride - Binary alloys - Chromium alloys - Fatigue testing - Gears - Impact testing - Materials testing apparatus - Nitriding - Quenching - Strengthening (metal)
Uncontrolled terms: 42crmo steel - Electron back scatter diffraction - Electron backscatter diffraction - Fatigue strength - Ion nitriding - Key process - Microstructure evolutions - Oil quenching - Preliminary heat treatment - XRD
Classification Code: 201.1.1 Metallurgy - 201.4.2 Foundry Practice - 201.7.1 Heat Treatment Processes - 202.3.1 Chromium and Alloys - 214.1.2 Fatigue, Cracks and Fracture - 215 Materials Testing - 215.1.1 Mechanical Properties Testing Equipment - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 804.2 Inorganic Compounds
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2. Optimization of the Hard-Tooth Surface Heat Treatment Process Parameters of Automotive Spiral Bevel Gears Based on Deformation and Performance Collaborative Control

Liu, Ganhua (1); Zhu, Zhipeng (1); Chen, Shaodong (1); Yu, Fuchao (1)
Source: *Journal of Materials Engineering and Performance*, 2026; **ISSN:** 10599495, **E-ISSN:** 15441024; **DOI:** 10.1007/s11665-026-13305-3; **Publisher:** Springer, Article in Press
Author affiliation: (1) School of Mechanical and Electrical Engineering, Jiangxi University of Science and Technology, Jiangxi, Ganzhou; 341000, China
Abstract: Automotive spiral bevel gears are typically manufactured from low-carbon alloy steel and undergo carburizing-quenching-tempering heat treatment, commonly referred to as hard-tooth surface heat treatment, to achieve a tough core and a surface with high hardness and wear resistance. However, distortion inevitably arises during the hard tooth heat treatment process, adversely affecting transmission performance and service life. To address this issue, a multi-physics coupled numerical model was established and experimentally validated to accurately predict gear deformation and microstructural evolution. The effects of key process parameters on cumulative tooth profile error and hardness were then systematically investigated using numerical simulation and experimental data. Furthermore, an integrated optimization methodology was developed, by combining a Particle Swarm Optimization-Backpropagation (PSO-BP) neural network,

the Non-dominated Sorting Genetic Algorithm II (NSGA-II), and the entropy weight method to synergistically control distortion and mechanical properties. The optimization strategy successfully improved gear performance while effectively mitigating distortion. Specifically, the validated parameters achieved a 14.61% reduction in the cumulative tooth profile error, decreasing it from 0.9318 mm to 0.7957 mm; tooth surface hardness increased by 0.74 HRC, from 58.84 HRC to 59.58 HRC; core hardness slightly raised by 0.06 HRC, from 40.15 HRC to 40.21 HRC. The strong agreement among numerical simulations, neural network predictions, and experimental results confirms the efficacy and considerable potential of the proposed methodology for enhancing quality control in the heat treatment of spiral bevel gears, offering a systematic solution for distortion control and performance enhancement in industrial gear production. © ASM International 2026. (30 refs)
Main heading: Bevel gears
Controlled terms: Gear manufacture - Gear teeth - Genetic algorithms - Hardness - Heat resistance - Heat treatment - Low carbon steel - Neural networks - Numerical methods - Particle swarm optimization (PSO) - Powertrains - Quality control - Surface resistance - Surface treatment
Uncontrolled terms: Automotives - Collaborative control - Hard-tooth surface heat treatment - Heat-treatment process - Multi-objectives optimization - Performance - Process parameters - Spiral bevel gears - Surface heat-treatment - Teeth surface
Classification Code: 101.1 Biomedical Engineering - 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1 Mechanical Properties of Materials - 214.2 Non-mechanical Properties of Materials - 601.2 Machine Components - 662.3 Automobile Components and Materials - 663.2 Heavy Duty Motor Vehicle Components - 701.1 Electricity: Basic Concepts and Phenomena - 913.3 Quality Assurance and Control - 1101 Artificial Intelligence - 1106 Computer Software, Data Handling and Applications - 1201.7 Optimization Techniques - 1201.9 Numerical Methods
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Data Provider: Engineering Village

3. Numerical Simulation for the Hard-Tooth Surface Heat Treatment Process of 20CrMnTi Steel Spiral Bevel Gear Based on Multifield Coupling Model (*Open Access*)

Liu, Ganhua (1); Yu, Fuchao (1); Chen, Shaodong (1); Wen, Yuqin (1)
Source: *Steel Research International*, v 96, n 7, July 2025; **ISSN:** 16113683, **E-ISSN:** 1869344X; **DOI:** 10.1002/srin.202400328; **Article number:** 2400328; **Publisher:** John Wiley and Sons Inc
Author affiliation: (1) School of Mechanical and Electrical Engineering, Jiangxi University of Science and Technology, Jiangxi, Ganzhou; 341000, China
Abstract: To obtain ideal fatigue resistance, low-carbon steel spiral bevel gears for axles generally undergo continuous carburizing-quenching-tempering heat treatment (hereinafter referred to as hard-tooth surface heat treatment). Herein, on the basis of multifield coupling effects, a multifield coupling model of hard-tooth surface heat treatment is established. The model considers the latent heat generated via phase transformation and the influence of surface carbon concentration on the temperature at which martensitic transformation commences (Ms). A numerical simulation and experimental verification are conducted on the hard-tooth surface heat treatment process for the 20CrMnTi steel spiral bevel gear. Results show that the maximum relative errors in carbon concentration, hardness, retained austenite content, and residual stress between the predicted and measured values are 4.8, 4.3, 4.6, and 7.6%, respectively. In addition, the article investigates the microstructure and stress evolution patterns of the spiral bevel gear during quenching. The results reveal that Ms decreases with increasing carbon concentration on the gear surface, resulting in the martensite transformation on the surface lagging significantly behind that at the core. The proposed model provides a reference for developing a formulating strategy for a realistic hard-tooth surface heat treatment process of spiral bevel gear. © 2024 Wiley-VCH GmbH. (30 refs)
Main heading: Quenching
Controlled terms: Bevel gears - Carburizing - Chromium steel - Gear teeth - Low carbon steel - Molybdenum steel
Uncontrolled terms: 20CrMnTi steels - Carbon concentrations - Fatigue-resistance - Hard-tooth surface heat treatment - Heat-treatment process - Low-carbon steels - Multi-field coupling models - Spiral bevel gears - Surface heat-treatment - Teeth surface
Classification Code: 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 601.2 Machine Components
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4. The Energy Consumption of Low-Pressure Heat Treatment Processes – Case Studies

Klos, Slawomir (1); Bazel, Michal (2)
Source: *Lecture Notes in Mechanical Engineering*, p 107-114, 2026, *Intelligent Systems in Production Engineering and Maintenance IV - Production Engineering*; **ISSN:** 21954356, **E-ISSN:** 21954364; **ISBN-13:** 9783032015167; **DOI:** 10.1007/978-3-032-01517-4_8; **Conference:** 5th International Conference on Intelligent Systems in Production Engineering and Maintenance, ISPEM 2025, June 25, 2025 - June 27, 2025; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) Institute of Mechanical Engineering, University of Zielona Góra, Licealna 9, Zielona Góra; 65417, Poland (2) Seco/Warwick S.A., Sobieskiego 8, Świebodzin; 66-200, Poland
Abstract: Low-pressure heat treatment processes are commonly used in industry, especially in such industries as automotive, machine construction, energy, etc. Due to their specificity, they are energy-intensive, which leads to high manufacturing costs of products in which they are used. The article presents an analysis of the selected low-pressure carburizing process due to energy consumption. Two vacuum furnace systems were taken into account, which consume the most energy in heat treatment processes: heating and pumping systems. Experimental studies were conducted using a vacuum furnace for heat treatment. Energy reduction was possible after limiting unnecessary work of both systems during the application of acetylene and nitrogen to the furnace chamber. After analyzing the characteristics of temperature and pressure changes during the carburizing process, changes in the control of the heating and pumping systems were proposed, which allowed for the reduction of energy consumption. After verifying the research in industrial practice, they can be implemented in the procedures of low-pressure carburizing of steel products. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2026. (11 refs)
Main heading: Industrial research
Controlled terms: Carburizing - Gears - Heat treating furnaces - Steel research - Vacuum furnaces - Vacuum pumps
Uncontrolled terms: Carburising - Energy - Energy-consumption - Heat-treatment process - Heating system - Low pressure carburising - Low pressure carburizing - Low pressures - Pumping systems - Sustainable development of manufacturing system
Classification Code: 201.2.1 Electric, Heat treating and Open Hearth Furnaces - 201.7 Heat Treatment - 201.7.1 Heat Treatment Processes - 202.5.3 Steel - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 609.2 Pumps - 901.3 Engineering Research - 912.1 Industrial Engineering - 1402.2 Vacuum Equipment
Funding Details: Number: INNOGLOBO /3/87/GRIP/2024/1,5/2024/12/833, Acronym: NCBiR, Sponsor: Narodowe Centrum Badań i Rozwoju; Number: -, Acronym: NCBiR, Sponsor: Narodowe Centrum Badań i Rozwoju;
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Database: Compendex
Data Provider: Engineering Village

5. Multi-Scale Full-Process Prediction and Performance Analysis of Carburizing and Quenching Heat Treatment

Jia, Zhicheng (1, 2); Chen, Yong (1, 2); Luo, Li (1, 2); Zhao, Hang (3)
Source: *JOM*, v 77, n 11, p 8137-8154, November 2025; **ISSN:** 10474838, **E-ISSN:** 15431851; **DOI:** 10.1007/s11837-025-07761-w; **Publisher:** Springer
Author affiliation: (1) Guangxi Key Laboratory of New Energy Vehicle Power Battery and Green Powertrain Domain, Nanning; 530004, China (2) Guangxi Colleges and Universities Engineering Research Center of Advanced Powertrain for New Energy Vehicles, Guangxi University, Nanning; 530004, China (3) Department of Electronic and Computer Engineering, The Hong Kong University of Science and Technology, Guangzhou; 510000, China
Abstract: This study focuses on FZG gears made of carburizing steel 20MnCrS5, considering the effects of carburizing hardening. A modified phase transformation kinetics formula and constitutive equation are introduced. Based on the 'phase – thermal – mechanical' coupling theory and multi-scale simulation methods, a diffusion – temperature – phase – stress – strain – hardness multi-field coupling model is established. The multi-scale and full-process "visualization" prediction of carburizing and quenching heat treatment under phenomenological phase transformation kinetics has been carried out. The results show that, under the H2 process, the surface carbon content is 0.763%, the residual austenite volume at the surface is 7.7%, the residual compressive stress is 513 MPa, the maximum deformation is 40 μm, the surface hardness is 696 HV, and the carburized layer depth is 1.02 mm. The prediction errors are 1.7%, 9%, 2.1%, 7.5%, 0.14%, and 2.9%, respectively. This confirms the feasibility of the multi-field coupling model. The study analyzes the mechanisms of carburizing diffusion kinetics, iron – carbon phase transformation, and carbide precipitation, revealing the effect of process parameters on microstructure and distortion. It also discusses the impact of surface integrity on gear fatigue contact life, offering new insights for optimizing carburizing heat treatment processes and enhancing macroscopic mechanical properties. © The Minerals, Metals & Materials Society 2025. (26 refs)
Main heading: Quenching

Controlled terms: Carbides - Carbon - Carburizing - Compressive stress - Gears - Hardness - Kinetics - Phase transitions - Thermal fatigue
Uncontrolled terms: Carburizing steel - Coupling theory - FZG gears - Multi-field coupling models - Multi-scales - Performances analysis - Phase transformations kinetics - Process performance - Process prediction - Thermal-mechanical coupling
Classification Code: 201.7.1 Heat Treatment Processes - 204.1 Ceramics - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 301.1 Fluid Flow - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 801.3 Physical Chemistry - 804 Chemical Products - 804.2 Inorganic Compounds
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Funding text: This paper was supported by the Guangxi Science and Technology Major Program (Grant No. Guike AA23062029) and Natural Science Foundation of Guang xi Zhuang Autonomous Region (2025GXNSFDA069050).
Database: Compendex
Data Provider: Engineering Village

6. Residual Stress Evolution and Stability: Assessing Heterogeneity and Relaxation in Gear Operation

Lima, Bruno (1); Rubik, Matheus (1); Rego, Ronnie (1)
Source: *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*, p 265-277, 2025, *American Gear Manufacturers Association Fall Technical Meeting, FTM 2025 - Held at the Motion + Power Technology Expo 2025*; **ISBN-13:** 9781643532035; **Conference:** American Gear Manufacturers Association Fall Technical Meeting, FTM 2025, October 22, 2025 - October 24, 2025; **Publisher:** AGMA American Gear Manufacturers Association
Author affiliation: (1) Aeronautics Institute of Technology, Brazil
Abstract: This study addresses the sensitive aspects of the residual stress heterogeneity and its impact on the relaxation phenomena during the gear's operation. The primary objective is to evaluate how the operational loads can change the residual stress state due to the initial heterogeneity, specifically aiming to correlate the impact of these changes within the gear lifetime. Fatigue tests were performed, in which samples with different conditions of number of cycles were evaluated to observe the residual stress relaxation. This approach enabled the evaluation of the residual stress stability of the samples based on the evolution of the residual stress state. Aspects such as contact pressure, cyclic deformations, and retained austenite transformation were considered to evaluate the shakedown. Preliminary results of the surface residual stress relaxation have already provided relevant information related to the tendency for relaxation during gear operation due to a higher heterogeneity level. The comprehensive analysis of the residual stress state highlights the potential to optimize the gear manufacturing chain. With that, this approach can make it possible to understand and achieve more stable residual stress profiles in gears, ensuring their benefits are maintained for a long period throughout the gear's lifetime. Copyright © (2025) by American Gear Manufacturers Association. All rights reserved. (16 refs)
Main heading: Stress relaxation
Controlled terms: Fatigue testing - Gear manufacture - Gear trains - Gears - Residual stresses
Uncontrolled terms: Condition - Contact pressures - Number of cycles - Operational loads - Primary objective - Relaxation phenomena - Residual stress relaxation - Residual stress state - Stress evolution - Stress stability
Classification Code: 214.1.1 Stress and Strain - 214.1.2 Fatigue, Cracks and Fracture - 215.1.2 Mechanical Properties Testing Methods - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 661 Automotive Engines and Related Equipment - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Database: Compendex
Data Provider: Engineering Village

7. Initial shape optimization of gears using response phase method (*Open Access*)

Nambu, Koichiro (1); Okumiya, Masahiro (2)
Source: *QDE 2025: Proceedings of the 3rd International Conference on Quenching and Distortion Engineering*, p 23-27, 2025, *QDE 2025: Proceedings of the 3rd International Conference on Quenching and Distortion Engineering*; **DOI:** 10.31399/asm.cp.qde2025p0023; **Conference:** 3rd International Conference on Quenching and Distortion Engineering, QDE 2025, June 6, 2025 - June 7, 2025; **Publisher:** ASM International
Author affiliation: (1) Osaka Sangyo University, 3-1-1, Nakagaito, Daito-city, Osaka; 574-8530, Japan (2) Toyota Technological Institute, 2-12-1, Hisakata, Tenpaku-ku, Aichi, Nagoya-city; 468-8511, Japan
Abstract: The miniaturization of automotive components requires higher precision in mechanical elements such as gears. Machining is necessary to achieve high precision, but there are issues such as increased costs and removal of surface

modification layers. From this point of view, it is necessary to design the initial shape to achieve the target dimensions after heat treatment, taking thermal strain into consideration. Our group is working on the optimization of the initial shape using the response phase method as a method for this purpose. In our previous research, we have been able to obtain a shape close to the target size after heat treatment of flat plates by optimizing the initial shape. In this study, we applied this method to gear geometry and optimized the initial geometry. To create the response phase, 220 models were created based on the D optimization plan. Finite element analyses were performed on these models. The finite element model is a three-coupled model that considers heat transfer, microstructural change, and stress. The response phase was created from the obtained results, and the initial shape was selected to minimize the strain after heat treatment as the objective function. It was confirmed that the initial shape optimization considering the heat treatment strain reduced the strain after heat treatment compared to the case without considering the heat treatment strain. These results indicate that the response phase method is effective in designing the initial shape to achieve the target dimensions after heat treatment.
Main heading: Shape optimization
Controlled terms: Design - Gears - Heat transfer - Heat treatment - Surface treatment
Uncontrolled terms: After-heat treatment - Automotive component - High-precision - Initial shape - Mechanical elements - Miniaturisation - Phase methods - Shape-optimization - Target dimensions
Classification Code: 201.7.1 Heat Treatment Processes - 208 Coatings, Surfaces, Finishes, Films and Deposition - 302.2 Heat Transfer - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 904 Design - 1201.7 Optimization Techniques
Open Access type(s): All Open Access, Bronze
Database: Compendex
Data Provider: Engineering Village

8. Study on grinding residual stress and parameter optimization of spiral bevel gears

Zhang, Fengshou (1); Chang, Jibao (1)
Source: *International Journal of Advanced Manufacturing Technology*, v 143, n 5-6, p 2375-2389, March 2026; **ISSN:** 02683768, **E-ISSN:** 14333015; **DOI:** 10.1007/s00170-025-17285-x; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) Henan University of Science and Technology School of Mechatronics Engineering, Luoyang; 471000, China
Abstract: This study comprehensively investigates the grinding process of spiral bevel gears and establishes a stochastic multi-grain finite element model using ABAQUS. A single-factor simulation approach is employed to systematically examine the depth-dependent distribution of residual stresses within the subsurface following grinding. Based on these results, a predictive model for residual stress is developed using a three-factor, four-level orthogonal experimental design. Grinding parameters are subsequently optimized through Grey Relational Analysis (GRA) and Particle Swarm Optimization (PSO), with a comparative evaluation of both methods conducted via the entropy weight approach. Key findings indicate that the machined tooth flanks exhibit a residual compressive stress state, with the maximum compressive stress located in the near-subsurface region. This stress gradually transitions to residual tensile stress with increasing depth, eventually approaching zero. Among the grinding parameters, depth of cut exerts the most pronounced influence on residual stress magnitude, followed by grinding speed, whereas feed rate has a comparatively minor effect. The GRA-based optimization scheme achieves superior solution quality compared with the PSO approach. Experimental validation demonstrates strong agreement between measured and simulated residual stress profiles, with overall discrepancies below 16%, thereby confirming the reliability of both the multi-grain simulation model and the predictive framework. These findings provide a robust theoretical foundation for optimizing the grinding process in spiral bevel gear manufacturing. (22 refs)
Main heading: Bevel gears
Controlled terms: Compressive stress - Grinding (machining) - Particle swarm optimization (PSO) - Stochastic models - Stochastic systems
Uncontrolled terms: Finite element modelling (FEM) - Grey relational analysis - Grinding parameters - Grinding process - Grinding residual stress - Multi-Grain - Parameter optimization - Parametric optimization - Spiral bevel gears - Stochastics
Classification Code: 214.1.1 Stress and Strain - 601.2 Machine Components - 604.2 Machining Operations - 1106 Computer Software, Data Handling and Applications - 1201.7 Optimization Techniques - 1202.1 Probability Theory
Funding Details: Number: HT-J2019-VII-0017-0159, Acronym: -, Sponsor: National Science and Technology Major Project; Number: -, Acronym: -, Sponsor: National Science and Technology Major Project; Number: 52175049, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China; Number: -, Acronym: NNSFC, Sponsor: National Natural Science Foundation of China;
Funding text: This work was completed with the support of the National Science and Technology Major Projects (HT-J2019-VII-0017-0159) and the National Natural Science Foundation of China (52175049).
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Data Provider: Engineering Village

9. Residual Stress Prediction of Internal Helical Gear Profile Grinding Based on FEA and RBF Neural Network (*Open Access*)

Li, Mingyu (1); Wang, Jianwen (2); Su, Jianxin (1, 3)
Source: *Modelling*, v 6, n 4, December 2025; **E-ISSN:** 26733951; **DOI:** 10.3390/modelling6040122; **Article number:** 122; **Publisher:** Multidisciplinary Digital Publishing Institute (MDPI)
Author affiliation: (1) School of Mechatronics Engineering, Henan University of Science and Technology, Luoyang; 471003, China (2) Zhejiang Tuoman Intelligent Technology Co., Ltd., Shaoxing; 321000, China (3) Longmen Laboratory, Luoyang; 471900, China
Abstract: As one of the most important finishing machining means of internal helical gear, the residual stress that appears during profile grinding plays an important role in transmission performance and the service internal helical gear. In this research, the residual stress simulation model of internal helical gear profile grinding is established to optimize and predict grinding parameters by means of a neural network. The grinding process parameters (including grinding depth, grinding feed speed, and grinding wheel linear speed) are taken as variable factors. Through experimental verification, the maximum error of the simulation value is 12.8%. The radial basis function (RBF) neural network is introduced, and simulation data samples are used to train and test the residual stress prediction model. Three groups of unknown grinding parameters are predicted, and the relative errors between the predicted and measured values are 5.16%, 1.63%, and 3.39%, respectively. The results demonstrate that the RBF neural network residual stress prediction model proposed in this paper is accurate and feasible. At the same time, the residual stress prediction method provides a theoretical basis for optimizing and controlling the precision of internal helical gear profile grinding. © 2025 by the authors. (25 refs)
Main heading: Residual stresses
Controlled terms: Forecasting - Grinding (machining) - Grinding wheels - Helical gears - Radial basis function networks
Uncontrolled terms: Gear profiles - Grinding parameters - Parameter prediction - Prediction modelling - Profile grinding - Radial basis function neural networks (RBF) - Residual stress prediction - Residual stress simulations - Simulation model - Transmission performance
Classification Code: 214.1.1 Stress and Strain - 601.2 Machine Components - 604.2 Machining Operations - 942.2.3 Abrasive Devices and Processes - 1101.2 Machine Learning - 1202 Statistical Methods
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Funding text: This research is funded by the National Natural Science Foundation of China (No. 52375052), the Natural Science Foundation of Henan Province (No. 242300421183), the Key R&D Program of Henan Province (No. 241111230300), and the Frontier Exploration Project of Longmen Laboratory (No. LMQYTSKT027).
Open Access type(s): All Open Access, Gold
Database: Compendex
Data Provider: Engineering Village

10. Impact of Front/Back Tension Differential on Widthwise Rolling Direction Residual Stress Distribution and Thickness-Profile Variation of AZ31B Magnesium Alloy Strip in Six-High Reversing Rolling

Zhi, Chenchen (1, 2, 3); Long, WenZhang (1, 2); Ma, Lifeng (1, 2, 3); Ji, Yafeng (1, 2); Zhang, Yang (1, 2); Jia, Weitao (1, 2); Huang, Zhiquan (1, 2); Liu, Pengtao (1, 2)
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Author affiliation: (1) School of Mechanical Engineering, Taiyuan University of Science and Technology, Taiyuan, China (2) Key Laboratory of Metallurgical Equipment Design Theory and Technology, Taiyuan University of Science and Technology, Shanxi, Taiyuan; 030024, China (3) National Key Laboratory of Advanced Stainless Steel, Taiyuan; 030024, China
Abstract: This study develops a strain-compensated Arrhenius constitutive model for AZ31B magnesium alloy by expressing the Arrhenius parameters as fourth-order polynomials of strain, achieving a correlation coefficient of R = 0.9431 and a mean absolute error of 10.78 MPa. The model is validated against independent hot deformation data and then implemented as the flow stress input in a thermomechanically coupled finite element model of six-high reversing rolling. Under the present modeling assumptions, a parametric finite element investigation is conducted to quantify the effects of rolling temperature, rolling speed, and the front–back tension differential ΔT = Tf – Tb on the widthwise distribution of the rolling direction residual stress component σ_RD, where Tf and Tb denote the exit and entry tensions applied along the rolling direction, respectively, and tensile stress is defined as positive. Within the simulated parameter space, increasing rolling

temperature and speed generally reduces the predicted edge-to-center difference and dispersion of σ_RD, whereas ΔT shows an approximately linear correlation with thickness reduction. For the present model configuration, the minimum predicted widthwise dispersion of σ_RD occurs at 673 K, 1.0 m/s, and ΔT = 4.5 kN, with a standard deviation of approximately 0.8 MPa, while the minimum predicted thickness variation among the simulated cases occurs at 523 K and 0.2 m/s, with an interquartile range of approximately 0.06%. © ASM International 2026. (38 refs)
Main heading: Magnesium alloys
Controlled terms: Computational mechanics - Dispersions - Gears - Hot rolling - Plastic flow - Polynomials - Residual stresses - Thickness control
Uncontrolled terms: AZ31B - AZ31B magnesium alloys - Back tension - Reversing mills - Rolling - Rolling direction - Rolling speed - Rolling temperature - Six-high reversing mill - Tension
Classification Code: 201.5.1.2 Rolling Mill Practice - 202.2.2 Magnesium and Alloys - 202.9.2 Alkaline Earth Metals - 214 Materials Science - 214.1.1 Stress and Strain - 214.1.3 Elasticity, Plasticity, Creep and Deformation - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 731.3 Specific Variables Control - 1201.1 Algebra and Number Theory - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

11. Thermo-mechanical coupling modeling of residual stress in internal gear power honing

Yuan, Bin (1); Xu, Zixiang (1); Han, Jiang (2); Ding, Wei (1); Zhang, Runmei (1); Tian, Xiaoqing (2); Xia, Lian (2)
Source: *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, v 48, n 3, March 2026; **ISSN:** 16785878, **E-ISSN:** 18063691; **DOI:** 10.1007/s40430-025-06177-6; **Article number:** 215; **Publisher:** Springer Science and Business Media Deutschland GmbH
Author affiliation: (1) Key Laboratory of Intelligent Manufacturing of Construction Machinery, Anhui Jianzhu University, Hefei; 230601, China (2) School of Mechanical Engineering, Hefei University of Technology, Hefei; 230009, China
Abstract: Power honing of internal gears is a key finishing process for high-performance transmission gears, and accurate control of residual stresses on the tooth surface is of great significance to ensure the strength and durability of the gears and to realize low-noise meshing. Based on the theory of misaligned spatial conjugate internal meshing, this study establishes a thermo-mechanical coupling model for the formation process of residual stress in power honed internal gears, derives a model for the relative velocity field of abrasive particles and honing force in the contact zone of gear honing, and successfully predicts the distribution of residual stress on the tooth surface through thermo-mechanical coupling stress analysis. The innovation of the model lies in the establishment of a thermo-mechanical coupling model based on physical principles, which directly correlates the contact kinematics with the machining force. In this paper, the framework system of mechanical force and thermal load is constructed, and an experimentally verified comprehensive prediction method of tooth residual stress is established. Taking the carburized quenched 20CrMnTi gears as a representative case, the residual stresses on the tooth surface are measured by power honing test, and the prediction results coincide with the measured values and the spatial distribution trend under different axial intersection angles, which verifies the reliability and applicability of the model. This study provides operable guidance for the selection of honing process for transmission system gears, which helps to ensure that the gears are in a favorable residual compressive stress state. © The Author(s), under exclusive licence to The Brazilian Society of Mechanical Sciences and Engineering 2025. (22 refs)
Main heading: Residual stresses
Controlled terms: Compressive stress - Electric power transmission - Gears - Honing - Honing machines - Reliability theory - Spatial distribution - Stress analysis - Transmissions
Uncontrolled terms: Coupling models - Finishing process - Internal gear - Performance - Power - Power honing - Teeth surface - Thermo - mechanical couplings - Thermo-mechanical coupling model - Transmission gear
Classification Code: 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1.1 Stress and Strain - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 603 Machine Tools - 706.1.1 Electric Power Transmission - 942.2.3 Abrasive Devices and Processes - 1201 Mathematics - 1202.2 Mathematical Statistics
Funding Details: Number: JZ202391,JZ202364, Acronym: AHJZU, Sponsor: Anhui Jianzhu University; Number: 300102252507, Acronym: -, Sponsor: -; Number: 52275483, Acronym: NNSF, Sponsor: National Natural Science Foundation of China; Number: IMCM2023KF02, Acronym: -, Sponsor: -; Number: SGCZXZD2101, Acronym: -, Sponsor: -;
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Database: Compendex
Data Provider: Engineering Village

12. Analysis of residual stress in helical gear teeth involute profile and helix in hobbing, shaving, carbonitriding, quenching and tempering processes

de Sousa Neves, Carlos Alberto (1, 2); Carneiro, José Rubens Gonçalves (1); da Silva, Gilmar Cordeiro (1); Martins, Paulo Sérgio (1, 2); Ba, Elhadji Cheikh Talibouya (3, 4); Firpe, Pedro Miraglia (5); Silva José, Anderson (2, 4); da Silva Braga, Leandro (2, 4); Miranda, Daniel Moreira (2, 4)
Source: *Forschung im Ingenieurwesen/Engineering Research*, v 89, n 1, December 2025; **ISSN:** 00157899, **E-ISSN:** 14340860; **DOI:** 10.1007/s10010-025-00932-w; **Article number:** 165; **Publisher:** Springer Vieweg
Author affiliation: (1) Department of Mechanical Engineering, Pontifícia Universidade Católica de Minas Gerias, Av, Dom José Gaspar 500, Minas Gerais, Belo Horizonte; CEP 30535-610, Brazil (2) STELLANTIS LATAM, Av, do Contorno da Fiat 3455, Minas Gerias, Betim; CEP: 32530-490, Brazil (3) Postgraduate Program in Mechanical Engineering, Universidade Federal de Uberlândia, Av. João Naves de Ávila Avenue 2121, Minas Gerais, Uberlândia; CEP: 38408-100, Brazil (4) Department of Materials Engineering, Centro Federal de Educação Tecnológica de Minas Gerias, Av, Amazonas 5253, Nova Suíça, Minas Gerais, Belo Horizonte; CEP: 30421-169, Brazil (5) Department of Mechanical Engineering, Ibmec, Rua Rio Grande do Norte, 300, Funcionários, Minas Gerais, Belo Horizonte; CEP: 30130-130, Brazil
Abstract: Low-alloy steels have become a mainstay in critical components like gears and shafts, due their cost-effectiveness and desirable mechanical properties. However, their inherent limitations highlight the need for innovative solutions to enhance their mechanical properties, particularly for applications demanding exceptional performance and durability. In all manufacturing processes, there are active forces to make the desired transformation of a given material, generating friction and, consequently, heat, to provide the formation, or not, of a chip. When these forces cease to act on the material, that is, when it remains at rest, residual stress is generated due to the efforts that led to the change in its structure (crystalline lattice). Stresses have a major effect on the physical, mechanical and chemical properties of the surface layer. Therefore, an appropriate residual stress can be obtained by selecting appropriate process parameters. Several studies have investigated the effect of machining processes separately on residual stress behavior. Based on this, this study aims to contribute to the advancement of research in gear manufacturing by presenting an investigation conducted in the automotive industry, in which residual stress was evaluated sequentially as a function of each stage of the manufacturing process—hobbing#→ shaving#→ carbonitriding—in manual transmission reduction gears manufactured from low-carbon manganese steel. It was demonstrated that different types of residual stresses are intrinsic to certain stages of the manufacturing process and that their transformations are interdependent, almost like a "memory" accumulated in each constructive phase of the component. © Der/die Autor(en), exklusiv lizenziert an Springer-Verlag GmbH Deutschland, ein Teil von Springer Nature 2025. (32 refs)
Main heading: Automotive industry
Controlled terms: Cost effectiveness - Durability - Gear manufacture - Gear teeth - Helical gears - Industrial research - Low carbon steel - Residual stresses - Steel research
Uncontrolled terms: Critical component - Helical gear teeth - Hobbing process - Low-alloy steel - Manufacturing process - Mechanical - Property - Quenching and tempering - Quenching process - Tempering process
Classification Code: 202.5.3 Steel - 214 Materials Science - 214.1 Mechanical Properties of Materials - 214.1.1 Stress and Strain - 601.2 Machine Components - 662.1 Automobiles - 901.3 Engineering Research - 911.2 Industrial Economics - 912.1 Industrial Engineering
Funding Details: Number: 70.040-031,00889834/0001-08, Acronym: CAPES, Sponsor: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior;
Funding text: This study was funded by CAPES, Coordination for the Improvement of Higher Education Personnel, Finance Code 001, which supported this work [Bras\u00EDlia, Brazil, CEP: 70.040-031, CNPJ: 00889834/0001-08].
Database: Compendex
Data Provider: Engineering Village

13. Entropy-based multi-criteria decision framework for plasma nitriding of hypoid gears

Hong Ky, Le (1)
Source: *International Journal on Interactive Design and Manufacturing*, 2026; **ISSN:** 19552513, **E-ISSN:** 19552505; **DOI:** 10.1007/s12008-026-02535-3; **Publisher:** Springer-Verlag Italia s.r.l., Article in Press
Author affiliation: (1) Vinh Long University of Technology Education, Vinh Long, Viet Nam
Abstract: This study proposes an entropy-based multi-criteria decision framework applied for the first time to interactively optimize plasma nitriding parameters for hypoid gears manufactured from SAE 5120 steel. The uniqueness of this research lies in the integration of the Entropy method for objective weighting combined with three advanced multi-criteria decision-making (MCDM) approaches: TOPSIS, PIV, and Harrington desirability, effectively overcoming the subjectivity inherent in traditional decision-making. Experimental results demonstrate that the proposed framework enables a consistent and robust ranking of process alternatives. Consequently, the optimal parameter set was specifically identified as a nitriding temperature of 510 °C, a treatment time of 4 h, and a gas flow rate of 6 l/h. This methodology serves as an effective decision-

support tool for interactive design and manufacturing environments involving complex surface engineering processes, which have remained largely unexplored in existing literature. (22 refs)
Main heading: Flow of gases
Controlled terms: Computer aided design - Decision making - Decision support systems - Entropy - Gears - Nitriding - Optimization - Plasma applications - Process control
Uncontrolled terms: Entropy weighting - Entropy-based - Hypoid gears - Interactive manufacturing - Multi criteria decision-making - Multicriteria decision - Multicriteria decision-making - Multicriterion decision makings - Plasma nitriding - Process optimisation
Classification Code: 201.7.1 Heat Treatment Processes - 301.1.2 Gas Dynamics - 301.2 Hydrodynamics - 302.1 Thermodynamics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 731 Automatic Control Principles and Applications - 904 Design - 912.2 Management - 913.3 Quality Assurance and Control - 1106 Computer Software, Data Handling and Applications - 1201.7 Optimization Techniques
Database: Compendex
Data Provider: Engineering Village

14. [Fluid-solid coupling heat transfer analysis of aerospace polymer gear transmission system]

Lin, Qinjie (1); Wu, Junfeng (2); Zhu, Caichao (1); Liu, Huaiju (1); Lu, Zehua (1)
Source: *Thermal Science and Engineering Progress*, v 69, January 2026; **E-ISSN:** 24519049; **DOI:** 10.1016/j.tsep.2025.104389; **Article number:** 104389; **Publisher:** Elsevier Ltd
Author affiliation: (1) State Key Laboratory of Mechanical Transmissions, Chongqing University, Chongqing; 400030, China (2) Beijing Aeronautical Manufacturing Technology Research Institute, AVIC, Beijing; 100024, China
Abstract: Aerospace polymer gear transmission systems operate at high speed and high temperature, where fluid–solid coupling heat transfer significantly impacts performance. This study proposes a long-term fluid–solid coupling heat transfer analysis method to address the timescale separation between flow and heat transfer processes. A numerical model of an aero-engine polymer accessory gearbox was established, considering component frictional heating, fluid viscous heating, and component motion. Results show fluid viscous heating is the primary driver of temperature rise, with maximum temperatures of 116 °C (gears), 118 °C (rolling bearings), and 122 °C (journal bearings), all below PEEK 450G's glass transition temperature. Gear no-load power loss accounts for 84 % of the total 2.2 kW loss. This work provides a reliable reference for the design and optimization of aerospace polymer gear systems. (40 refs)
Main heading: Glass transition
Controlled terms: Aerospace engineering - Electric load loss - Electric losses - Electric power transmission - Friction - Gear transmissions - Gears - Heat transfer performance - High temperature applications - Power transmission - Temperature - Transmissions
Uncontrolled terms: Aerospace gear transmission - Flow-solid coupling heat transfer - Fluid-solid coupling - Gear transmission system - Gear transmissions - Heat transfer analysis - High Speed - Highest temperature - Powerloss - Viscous heating
Classification Code: 302.1 Thermodynamics - 302.2 Heat Transfer - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 657 Aerospace Engineering, Other Topics - 662.3 Automobile Components and Materials - 704.2 Electric Equipment - 706.1.1 Electric Power Transmission - 706.1.2 Electric Power Distribution - 802.3 Chemical Operations - 1009.1 Energy Conservation - 1301.1.1 Mechanics
Funding Details: Number: U2141247,52322504,JCKY2024213B006, Acronym: NNSF, Sponsor: National Natural Science Foundation of China;
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Database: Compendex
Data Provider: Engineering Village

15. [Study on the influence of gear pair operating parameters on heat transfer characteristics of lubrication systems and global sensitivity analysis]

Hou, Yankun (1); Lyu, Yaguo (1); Tian, Jiaolei (1); Liu, Zhengang (1)
Source: *Case Studies in Thermal Engineering*, v 74, October 2025; **ISSN:** 2214157X; **DOI:** 10.1016/j.csite.2025.106898; **Article number:** 106898; **Publisher:** Elsevier Ltd
Author affiliation: (1) School of Power and Energy, Northwestern Polytechnical University, Xi'an; 710072, China
Abstract: Given the urgent demand for lightweight design and energy conservation in aviation engines, this study investigates the impact of gear pair operating parameters on the heat transfer characteristics of the lubrication system. By

establishing a gear jet lubrication testing platform, the influence of parameters such as gear rotational speed and supply flow rate on the supply-scavenge oil temperature difference, as well as heat generation power, is systematically revealed. Using a Back Propagation (BP) neural network, we developed a nonlinear mapping model that links operating parameters and heat transfer characteristics. Through the application of the Sobol' global sensitivity analysis method, parameters that significantly contribute to heat transfer characteristics are identified. The results indicate that gear rotational speed and supply flow rate, along with their synergistic effects, play a dominant role in determining heat transfer characteristics. A cooling benefit is proposed as a quantitative indicator, and by defining the rate of temperature change resulting from flow variation, a parameter sensitivity threshold decision mechanism is established. This mechanism balances the supply-scavenge oil temperature difference and heat generation power from the perspective of the lubrication system. This study provides a feasible improvement pathway for the lightweight design of lubrication systems. © 2025 The Authors. (46 refs)
Main heading: Sensitivity analysis
Controlled terms: Backpropagation - Cooling systems - Fighter aircraft - Gears - Heat engines - Heat generation - Heat transfer - Lubrication - Neural networks - Well testing
Uncontrolled terms: Cooling benefit - Gear pairs - Gear power loss - Global sensitivity analysis - Heat-transfer characteristics - Jet lubrications - Lubrication system - Operating parameters - Powerloss - Sensitivity analyzes
Classification Code: 101.1 Biomedical Engineering - 302 Thermodynamics and Heat Transfer - 302.2 Heat Transfer - 305.3 Refrigeration Equipment and Components - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 606.2 Lubrication - 608 Engines - 652.1.2 Military Aircraft - 1101 Artificial Intelligence - 1101.2 Machine Learning - 1201 Mathematics
Funding Details: Number: J2019-III-0023-0067, Acronym: -, Sponsor: National Major Science and Technology Projects of China;
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Database: Compendex
Data Provider: Engineering Village

16. Synergistic enhancement of DLC film performance on gear steel: Plasma nitriding for optimized mechanical and tribological properties

Chen, Jingyi (1, 2); Shang, Lunlin (2); He, Dongqing (3); Liu, Xing (4); Zhang, Guangan (2); Wang, Shunhua (1)
Source: *Diamond and Related Materials*, v 159, November 2025; **ISSN:** 09259635; **DOI:** 10.1016/j.diamond.2025.112748; **Article number:** 112748; **Publisher:** Elsevier Ltd
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Abstract: Single-layer DLC film on gear steel exhibits limited mechanical and tribological performance due to weak adhesion and insufficient load-bearing capacity. An effective method to improve the properties of DLC film is to strengthen the gear steel surface by introducing nitriding pretreatment. In this study, PN/DLC and P-PN/DLC duplex layers were prepared on the 30CrMnSiNi2A gear steel by a combination of plasma nitriding and magnetron sputtering, and their properties were analyzed in comparison with single-layer DLC film. The results indicated that the mechanical and tribological properties of the PN/DLC and P-PN/DLC duplex layers were significantly improved. In particular, the bonding strength and hardness of the PN/DLC duplex layer increased by 46 % and 43 %, respectively, compared to the single-layer DLC film, due to the reinforced gear steel surface and mechanical interlocking. Furthermore, the polishing treatment of the nitrided layer is crucial, as it eliminates surface micro-convexities, greatly reduces roughness, suppresses the ploughing effect during the friction process, and facilitates a change in the wear mechanism from abrasive wear to oxidative wear. This results in the optimal tribological performance of the P-PN/DLC duplex layer, with a coefficient of friction of about 0.12, and a wear rate of only 1.44 × 10−8 mm3/(N·m) - approximately 57.5 % lower than that of the single-layer DLC film. Obviously, the strategy of preparing duplex layers by nitriding and magnetron sputtering provides a practical surface modification method for high-performance gear systems. © 2025 Elsevier B.V. (53 refs)
Main heading: Plasma applications
Controlled terms: Aluminum nitride - Bearings (machine parts) - Chromium alloys - Friction - Gears - Magnetron sputtering - Manganese alloys - Nitriding - Polishing - Titanium nitride - Wear of materials
Uncontrolled terms: DLC film - Duplex layer - Gear steels - Mechanical and tribological properties - Mechanical performance - Plasma nitriding - Polishing treatment - Single layer - Tribological properties - Wear mechanisms
Classification Code: 201.7.1 Heat Treatment Processes - 202.3.1 Chromium and Alloys - 202.3.2 Manganese and Alloys - 208 Coatings, Surfaces, Finishes, Films and Deposition - 208.3 Deposition Techniques - 214 Materials Science - 301.2 Hydrodynamics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 604.2 Machining Operations - 606 Lubrication and Tribology - 804.2 Inorganic Compounds - 942.2.3 Abrasive Devices and Processes - 1301.1.1 Mechanics

Funding Details: Number: 202300540N8005,JCKY2023130C005, Acronym: -, Sponsor: Aeronautical Science Foundation of China; Number: -, Acronym: -, Sponsor: Aeronautical Science Foundation of China;
Funding text: This work was co-supported by the Aeronautical Science Foundation of China (No. 202300540N8005) and the Basic Scientific Research program of China (No. JCKY2023130C005).
Database: Compendex
Data Provider: Engineering Village

17. Effects of Air Gaps on Heat Transfer and Energy Distribution in Protective Fabrics for Firefighting (*Open Access*)

Zhang, Shuyang (1); Tian, Miao (1, 2, 3); Li, Jun (1, 2, 3)
Source: *Fire and Materials*, v 50, n 3, p 308-317, April 2026; **ISSN:** 03080501, **E-ISSN:** 10991018; **DOI:** 10.1002/fam.70046;
Publisher: John Wiley and Sons Ltd
Author affiliation: (1) College of Fashion and Design, Donghua University, Shanghai, China (2) Protective Clothing Research Center, Donghua University, Shanghai, China (3) Key Laboratory of Clothing Design and Technology, Donghua University, Ministry of Education, Shanghai, China
Abstract: This research investigates the influence of air gap (AG) thickness and boundary conditions on the thermal storage and release characteristics of firefighter turnout gear. The study focuses on how AGs modify heat transfer mechanisms and affect energy distribution within fabric systems. By simulating a low-radiation environment, the effects of varying AG thicknesses on stored energy, heat absorption, and cooling rates of fabric layers are systematically analyzed. The findings suggest that a closed AG with a thickness of 6.4 mm enables the fabric system to store 24% more energy at its center in comparison to fabric systems devoid of an AG, with the total stored energy reaching 138.5 kJ/m2. Furthermore, AGs exceeding 6.4 mm have been shown to significantly enhance lateral energy transfer, thereby improving energy uniformity across layers. Additionally, an increase in AG thickness from 6.4 to 12 mm has been observed to slow the cooling rate at the thermal liner (TL) surface by 18.7%. In open AG conditions, convective effects dominate, enhancing heat dissipation and storing energy more evenly. Furthermore, a transition from a closed to an open AG (≥ 6.4 mm) results in a 14.2% decrease in energy retention and a reduction in temperature gradients (p © 2026 John Wiley & Sons Ltd. (22 refs)
Main heading: Boundary conditions
Controlled terms: Absorption cooling - Energy transfer - Gears - Heat convection - Heat storage - Protective coatings - Radiation effects - Thermal insulating materials
Uncontrolled terms: Air gap thickness - Air-gaps - Energy - Energy distributions - Energy release - Fabric systems - Multi-layer fabrics - Multilayer fabric system - Stored energy - Thermal protection
Classification Code: 208.2 Coating Materials - 217.3.2 Heat Insulating Materials - 301.1 Fluid Flow - 302 Thermodynamics and Heat Transfer - 302.2 Heat Transfer - 304.3 Air Conditioning - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 1001.3.2 Radiation Effects - 1009 Energy Management - 1009.4 Energy Storage
Funding Details: Number: 2232023D‐06,2232025G‐08, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities; Number: -, Acronym: -, Sponsor: Fundamental Research Funds for the Central Universities;
Funding text: This study was supported by the Fundamental Research Funds for the Central Universities (Grant No. 2232023D\u201006 and 2232025G\u201008).
Open Access type(s): All Open Access, Bronze
Database: Compendex
Data Provider: Engineering Village

18. A comparative analysis of the nitriding process on EN alloy steel for internal gear application in the automotive industry

Mahendiran, M. (1); Barik, Debabrata (1); Prabagaran, Subramaniam (2)
Source: *Sadhana - Academy Proceedings in Engineering Sciences*, v 51, n 2, June 2026; **ISSN:** 02562499, **E-ISSN:** 09737677; **DOI:** 10.1007/s12046-026-03067-y; **Article number:** 62; **Publisher:** Springer
Author affiliation: (1) Department of Mechanical Engineering, Karpagam Academy of Higher Education, Coimbatore; 641 021, India (2) Karpagam Innovation and Incubation Council, Coimbatore; 641 021, India
Abstract: The method of nitriding involves the use of glow discharge for surface modification. It is commonly used to improve the endurance, resistance to wear, resistance to corrosion, and surface hardness of steel. The study's objective was to evaluate the nitriding process (liquid, gas, and plasma nitriding) on various grades of steel (20MnCr5, EN19, and EN41B) in terms of hardness attributes, case depth analysis, dimensional correctness, and white layer production. The microstructural analysis was conducted using a metallurgical microscope, a microhardness tester, and XRD-EDS. The white layer is the uppermost layer characterized by a significant concentration of nitrogen atoms, situated between the surface and the underlying layer. The findings indicate that for EN19, the decrease in the white layer was less than 10 microns, making it

almost 60% smaller than the other two gear materials, specifically 20MnCr5 and EN41B. 20MnCr5 exhibits lower hardness and diminished core strength compared to the other two materials, EN19 and EN41B. The formation of precipitates is smaller in size, and there are a greater number in both alloy steels. As the temperature increases, the size, distortion, and visibility of the precipitates increase. © Indian Academy of Sciences 2026. (16 refs)
Main heading: Automotive industry
Controlled terms: Binary alloys - Chromium alloys - Gears - Glow discharges - Hardness - Manganese alloys - Nitrogen plasma - Plasma applications - Steel corrosion - Steel metallurgy - Surface resistance - Surface treatment - Ternary alloys
Uncontrolled terms: Advanced gear tester - Alloy steel gear - Automotives - Characterization - Comparative analyzes - Gears application - Internal gear - Nitriding process - Steel gears - White layer
Classification Code: 201.1.1 Metallurgy - 201.9.1 Metals Corrosion - 202.3.1 Chromium and Alloys - 202.3.2 Manganese and Alloys - 202.5.3 Steel - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214.1 Mechanical Properties of Materials - 301.2 Hydrodynamics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 662.1 Automobiles - 701.1 Electricity: Basic Concepts and Phenomena - 711.1 Electromagnetic Waves in Different Media - 1301.2.3 Plasma Physics
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Database: Compendex
Data Provider: Engineering Village

19. A new formulation for convective heat transfer in oil jet lubricated spur gears

Torres, Thibaut (1, 2); Changenet, Christophe (1); Touret, Thomas (1); Guilbert, Bérengère (2)
Source: *Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology*, v 239, n 9, p 1232-1245, September 2025; **ISSN:** 13506501, **E-ISSN:** 2041305X; **DOI:** 10.1177/13506501251347718; **Publisher:** SAGE Publications Ltd
Author affiliation: (1) ECAM LaSalle, LabECAM, Lyon; 69005, France (2) INSA Lyon, CNRS, LaMCoS, UMR 5259, Villeurbanne; 69621, France
Abstract: This study aims to analyze thermal heat-transfer between an oil jet and a rotating spur gear using a novel experimental methodology1to have an analytical model based on lubrication conditions and geometric characteristics of spur gears. Based on existing theoretical formulations and advanced visualization techniques implemented on a test bench. The use of a high-speed image acquisition system allowed the identification of three distinct phases, depending on the gear rotational speed, which led to the development of the heat-transfer model. This research considers various types of spur gears to account for geometric variations and different lubrication conditions, namely different oil jet flow rates and/or nozzle diameters. These results provide a new perspective on understanding convective transfers in mechanical transmissions. © IMechE 2025 (28 refs)
Main heading: Spur gears
Controlled terms: Fighter aircraft - Geometry - Heat convection - High speed cameras - Lubrication - Thermal modeling - Thermography (temperature measurement)
Uncontrolled terms: Convective heat transfer - Heat transfer by convections - Jetflows - Lubrication / - Lubrication condition - Oil jets - Pressurized oil - Pressurized oil-jet flow - Thermal heat - Thermal model
Classification Code: 302.2 Heat Transfer - 601.2 Machine Components - 606.2 Lubrication - 652.1.2 Military Aircraft - 742.2 Photographic and Video Equipment - 941.8 Temperature Measurements - 1201.12 Modeling and Simulation - 1201.14 Geometry and Topology
Funding Details: Number: 2022-42, Acronym: DGAC, Sponsor: Direction générale de l'aviation civile; Number: -, Acronym: DGAC, Sponsor: Direction générale de l'aviation civile;
Funding text: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Direction g\u00E9n\u00E9rale de l'aviation civile, (grant number 2022-42).The authors would like to express their thanks to the Direction G\u00E9n\u00E9rale de l\u2019Aviation Civile (DGAC) for funding this research, grant number 2022-42.
Database: Compendex
Data Provider: Engineering Village

20. Effect of inoculation technique and treatment temperature on the shrinkage propensity of ductile iron castings

Sangame, Bahubali Babanrao (1); Reddy, Y. Prasannatha (2); Chavan, Abhijeet G. (3)

Source: *Multidiscipline Modeling in Materials and Structures*, p 1-20, 2025; **ISSN:** 15736105, **E-ISSN:** 15736113; **DOI:** 10.1108/MMMS-08-2025-0306; **Publisher:** Emerald Publishing, Article in Press
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Abstract: Purpose – This article investigates the impact of the method of inoculant addition on the solidification and shrinking tendency. Commercial foundries that manufacture ductile iron castings typically employ a conventional magnesium treatment, followed by an inoculation treatment. There is a lack of comprehensive studies on examining the impact of mixing an inoculant with a magnesium alloy during the process of magnesium treatment. Design/methodology/approach – In this study, an industrial gear housing hub casting is used to conduct studies comparing the shrinkage tendency of the casting when subjected to single-step inoculation versus two-step inoculation. Thermal analysis cups are poured to get the solidification cooling curves for 27 heats of castings. The analyzed solidification data is used to establish a correlation between inoculation method versus microstructure and shrinkage tendency of gear housing hub casting. Findings – The two-stage inoculation process in ductile cast iron, comprising pre-inoculation and stream inoculation, serves as an effective approach for minimizing recalescence ΔTR and solidification angle Θ. The relationship between recalescence, solidification angle Θ and shrinkage has been developed for 27 heats of gear housing hub castings. It was observed that the number of castings exhibiting shrinkage in the respective heats increases with rising recalescence and solidification angle Θ. The recalescence ΔTR plays a crucial role in the management of shrinkage. The single-stage inoculation was performed on 27 heat samples, with the highest recorded recalescence temperature being 10 °C. The shrinkage porosity defect occurs in 18 castings at the specified recalescence temperature. In a similar manner, a two-stage inoculation process is conducted on an additional 27 samples utilizing the same heat treatment. The highest recorded recalescence during this process is 9 °C, and a shrinkage porosity defect is identified in 9 castings at this recalescence temperature. Originality/value – To enhance the quantity and size distribution of nodules, thereby minimizing shrinkage in ductile cast iron, it is more beneficial to add 0.15% inoculant during magnesium treatment and then inoculate with a 0.25% transfer ladle stream. This approach differs from simply inoculating with a 0.4% stream. © 2026 Emerald Publishing Limited (29 refs)
Main heading: Magnesium castings
Controlled terms: Defects - Ductility - Gears - Heat treatment - Housing - Magnesium alloys - Metal casting - Nodular iron - Porosity - Shrinkage - Solidification - Thermoanalysis
Uncontrolled terms: Cooling curve - Ductile cast irons - Ductile iron castings - Gear housings - Inoculation - Inoculation process - Magnesium treatment - Porosity defects - Recalescence - Shrinkage porosity
Classification Code: 201.1.2 Metallography - 201.4.2 Foundry Practice - 201.7.1 Heat Treatment Processes - 202.2.2 Magnesium and Alloys - 202.5.1 Iron - 202.9.2 Alkaline Earth Metals - 214 Materials Science - 403.1 Urban Planning and Development - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 801.3 Physical Chemistry - 802.3 Chemical Operations - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Database: Compendex
Data Provider: Engineering Village

21. Enhanced Fatigue Performances of Heat Treated Lean Chromium Alloyed PM Steels

Sundaram, Maheswaran Vattur (1); Andersson, Michael (1)
Source: *Euro Powder Metallurgy 2025 Congress and Exhibition, Euro PM 2025*, 2025, *Euro Powder Metallurgy 2025 Congress and Exhibition, Euro PM 2025*; **ISBN-13:** 9798331328221; **DOI:** 10.59499/EP256767821; **Conference:** 2025 Euro Powder Metallurgy Congress and Exhibition, Euro PM 2025, September 14, 2025 - September 17, 2025; **Sponsor:** et al.; Hilti; Hoeganaes; Miba; Plansee; RioTinto; **Publisher:** European Powder Metallurgy Association (EPMA)
Author affiliation: (1) Höganäs AB, Höganäs; SE-26383, Sweden
Abstract: Astaloy® CrS is a sustainable alternative to Fe-Cu-C PM steels that can also be heat treated in a conventional way with gas carburisation and oil quenching. When heat treated this material has the potential to reach performance levels of Mo-prealloyed PM steels. To achieve improved fatigue performance, the evaluation was performed in two stages. First by varying the heat treatment parameters such as carburisation temperature and holding time. Secondly, Ni and graphite amounts were varied, applying carburisation at low temperature, to realise the full potential of this material. The performance was benchmarked against other materials. By optimising heat treatment and mix compositions, fatigue performance has significantly improved, making Astaloy CrS superior to Fe-Cu-C and equivalent to that of Mo-prealloyed PM steels. © European Powder Metallurgy Association (EPMA) (8 refs)
Main heading: Temperature
Controlled terms: Carburizing - Chromium alloys - Chromium compounds - Copper alloys - Copper compounds - Gears - Low temperature operations - Molybdenum alloys - Steel - Thermal fatigue
Uncontrolled terms: Carburisation - Fatigue performance - Heat treatment parameters - Holding time - Lows-temperatures - Oil quenching - Performance - Performance:level - PM steels - Prealloyed

Classification Code: 201.7.1 Heat Treatment Processes - 202.3.1 Chromium and Alloys - 202.3.3 Molybdenum and Alloys - 202.4.1 Copper - 202.4.2 Copper Alloys - 202.5.3 Steel - 204.3 Refractories - 214 Materials Science - 302.1 Thermodynamics - 305.4 Cryogenics - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 804.2 Inorganic Compounds
Database: Compendex
Data Provider: Engineering Village

22. A GPU-Accelerated Fully Coupled Fluid–Solid–Thermal SPH Solver for Industrial Gearboxes: Application to Lubricant Flow and Heat Transfer in a Bevel–Helical Reducer

Yu, Yongchuan (1, 2); Wu, Dong (2, 3); Haidn, Oskar J. (1); Hu, Xiangyu (3)
Source: *arXiv*, December 10, 2025; **E-ISSN:** 23318422; **DOI:** 10.48550/arXiv.2512.09904; **Repository:** arXiv
Author affiliation: (1) Technical University of Munich, Ottobrunn; 85521, Germany (2) EinSIMO GmbH, München; 80687, Germany (3) Technical University of Munich, Garching bei München; 85748, Germany
Abstract: This study presents a GPU-accelerated, fully coupled fluid–solid–thermal Smoothed Particle Hydrodynamics (SPH) framework for high-fidelity analysis of splash-lubricated gearboxes. A series of thermo–fluid simulations of a bevel–helical gear reducer were conducted by varying shaft speed, oil immersion depth, and lubricant viscosity to evaluate their influence on splash dynamics, churning losses, and lubricant temperature rise. The results show that churning losses increase by nearly an order of magnitude as the speed rises from 150 to 600 rad/s, while the corresponding lubricant temperature rise becomes approximately three to four times smaller. Variations in immersion depth and viscosity adjust the heating rate only modestly—typically within 10–20%—with their influence reversing between low- and high-speed regimes. The GPU backend provides a 7–9× speedup over a high-performance desktop CPU, enabling multi-million-particle, full-gearbox thermo–fluid simulations without specialized hardware. These findings demonstrate the feasibility of high-fidelity thermal analysis of industrial gearboxes and provide quantitative insight into the coupled splash, churning, and heat-transfer mechanisms that govern gearbox thermal performance. Copyright © 2025, The Authors. All rights reserved. (48 refs)
Main heading: Hydrodynamics
Controlled terms: Bevel gears - Graphics processing unit - Heat transfer performance - Helical gears - Program processors - Solid lubricants - Thermoanalysis - Viscosity
Uncontrolled terms: Accelerated simulations - Bevel-helical gear reducer - Churning loss - Fluid-solid coupling - Gear reducers - GPU-accelerated - GPU-accelerated simulation - Lubricant splash - Smoothed particle hydrodynamic - Smoothed particle hydrodynamics - Thermal fluids - Thermal-fluid-solid coupling
Classification Code: 301.1 Fluid Flow - 301.2 Hydrodynamics - 302.2 Heat Transfer - 601.2 Machine Components - 606.1 Lubricants - 714.2 Semiconductor Devices and Integrated Circuits - 801.3 Physical Chemistry - 1102.3.1 Computer Circuits - 1106.1 Computer Programming - 1301.1.2 Physical Properties of Gases, Liquids and Solids
Database: Compendex
Data Provider: Engineering Village

23. Impact of nanoparticle shape on heat transfer in nanofluid flow over a rotating inclined disk with viscous dissipation

Gupta, Reshu (1)
Source: *Proceedings of the Institution of Mechanical Engineers, Part N: Journal of Nanomaterials, Nanoengineering and Nanosystems*, 2026; **ISSN:** 23977914, **E-ISSN:** 23977922; **DOI:** 10.1177/23977914261426156; **Publisher:** SAGE Publications Ltd, Article in Press
Author affiliation: (1) Applied Science Cluster (Mathematics), UPES, Uttarakhand, Dehradun, India
Abstract: In the presence of heat radiation, the current work aims to investigate the analysis of the transmission of heat the nanofluid flow due to the rotating and inclined disk. The novelty of the current work is to investigate the effect of five different shapes of nanoparticles. It is assumed that each of the five different-shaped nanoparticles has the same diameter ($dp = 45$ nm). Every shape is suspended in the same volume. The study is needed because normal nanofluids cannot remove heat effectively, and by transforming the shape of nanoparticles, heat transfer can be improved. The results of study are suitable for real systems like gas turbines, rotating machines, and cooling devices that use inclined rotating disks. Both joule heating and viscous-dissipation components of the heat transmission process are taken into consideration. Aluminum oxide suspended in silicon oil make up the nanofluid. Inclined rotating disks are employed in gas turbines and aerospace engines to control thermal loads. High mechanical and thermal stresses are placed on inclined rotating disks found in wind turbines and industrial gearboxes. Based on the results, the heat transfer system is much improved and becomes more realistic when thermal radiation is included. A collection of nonlinear partial differential equations (PDEs) and related boundary conditions are defined in the mathematical formulation section. To convert the suggested mathematical system of nonlinear PDEs into a system of nonlinear ordinary differential equations (ODEs) with boundary conditions (BCs), an appropriate similarity transformation is applied. The differential transform method is then used to solve the amended

equations. A more comprehensive understanding of this system's heat transfer properties can be obtained from graphs and showing the precise dimensions of profile findings for different flow parameters. It can be observed that on increasing porosity, the temperature of nanofluid (NF) also increases because fluid motion enhances viscous dissipation, which converts kinetic energy into thermal energy which raising the temperature. Also, on increasing the volume fraction from 0% to 5%, skin friction coefficient decreases 10%–15%. By comparing the produced results with established results in literature and numerical method results, the accuracy of the results calculated by differential transform method (DTM) has been established and there is a good agreement between them. © IMechE 2026 (40 refs)
Main heading: Nanofluidics
Controlled terms: Aluminum oxide - Boundary conditions - Cooling systems - Energy dissipation - Friction - Gas turbines - Gears - Heat radiation - Kinetic energy - Mathematical transformations - Nonlinear equations - Ordinary differential equations - Partial differential equations - Porous materials - Rotating disks - Transmissions - Viscous flow - Volume fraction
Uncontrolled terms: 'current - Differential transform method - Inclined disk - Nanofluid flow - Nanofluids - Porous medium - Rotating disc - Shape of nanoparticle - Thermal - Viscous dissipation
Classification Code: 214 Materials Science - 301.1 Fluid Flow - 301.1.5 Flow of Fluid-Like Materials - 302 Thermodynamics and Heat Transfer - 302.2 Heat Transfer - 302.3 Mass Transfer - 305.3 Refrigeration Equipment and Components - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 602.2 Mechanical Transmissions - 608.3 Gas Turbines and Engines - 761 Nanotechnology - 804.2 Inorganic Compounds - 1009.1 Energy Conservation - 1009.2 Energy Consumption - 1201.1 Algebra and Number Theory - 1201.2 Calculus and Analysis - 1201.3 Mathematical Transformations - 1301.1.1 Mechanics - 1401.4.2 Nanofluidics
Database: Compendex
Data Provider: Engineering Village

24. [Comparison of dry sliding wear behavior and microstructural properties of AISI 8620 steel after gas carburization, gas nitriding, and pack boronization surface treatments]

Basyigit, Aziz Baris (1); Sahin, Omer (2); Bayca, Salih Ugur (3); Kilicli, Volkan (2)
Source: *Materialpruefung/Materials Testing*, v 68, n 1, p 37-49, January 1, 2026; **ISSN:** 00255300, **E-ISSN:** 21958572; **DOI:** 10.1515/mt-2025-0316; **Publisher:** Walter de Gruyter GmbH
Author affiliation: (1) Department of Metallurgical and Materials Engineering, Kirikkale University, Kirikkale, Turkey (2) Department of Metallurgical and Materials Engineering, Gazi University, Ankara, Turkey (3) Department of Metallurgical and Materials Engineering, Alaaddin Keykubat University, Alanya, Turkey
Abstract: AISI 8620 steel is used in gears and machine parts where surface wear resistance is important. The presented study focuses on different surface hardening treatments on microstructural properties and the dry sliding wear behavior of the AISI 8620 steel. The dry sliding wear test used a tribometer with constant wear test parameters according to ASTM G-99 standard. The microstructures were characterized by optical and scanning electron microscopy (SEM), energy-dispersive X-ray (EDX), and X-ray diffraction (XRD). The highest surface hardness (~1,507 HV) occurs in the boronized sample, attributed to the hard, iron borides (FeB, Fe2B, Fe3B) layers. The minimum surface hardness (~507 HV) is determined in nitrided samples. The maximum case hardening depth (~0.90 mm) is obtained in nitrided samples, as the minimum value of case depth (~0.1 mm) was found in boronized samples. The mean coefficient of friction was highest for nitrided (0.622) and lowest for boronized (0.367) samples. Boronizing also gave the minimum wear (1.705mm3, 1 mg), compared with nitriding (13.5mm3, 1.8 mg) and carburizing (43.57mm3, 4.9 mg). The boronized samples exhibited the best wear properties. According to the optical profilometer results of worn samples; the carburized sample exhibits a broad and deep wear track (volume loss 43.57mm3), indicating severe abrasive wear due to lower surface hardness, the boronized sample showed the narrowest and shallowest wear track (volume loss 1.705mm3), because of superior wear resistance from the dense, hard iron boride layer while the nitrided sample having moderate wear depth and volume loss (13.5mm3), indicating intermediate wear resistance attributed to a thinner, harder nitride layer providing moderate protection. © 2026 Walter de Gruyter GmbH. All rights reserved. (38 refs)
Main heading: Carburizing
Controlled terms: Aluminum nitride - Borides - Boron nitride - Chromium compounds - Friction - Gears - Hardness - Surface resistance - Wear of materials - Wear resistance
Uncontrolled terms: AISI 8620 steel - Boronizing - Dry sliding wear - Micro-structural properties - Nitrided - Sliding wear behaviour - Surface hardening - Surface hardness - Volume loss - Wear behaviors
Classification Code: 201.7.1 Heat Treatment Processes - 204.1 Ceramics - 204.3 Refractories - 208 Coatings, Surfaces, Finishes, Films and Deposition - 214 Materials Science - 214.1 Mechanical Properties of Materials - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 701.1 Electricity: Basic Concepts and Phenomena - 804.2 Inorganic Compounds - 1301.1.1 Mechanics
Database: Compendex
Data Provider: Engineering Village

25. Applications of Laser Surface Treatment in Gears: A Review (*Open Access*)

Zhang, Bowen (1, 3); Sun, Linlin (1, 2); Zhao, Ning (1, 3, 4); Li, Jinran (1, 3)
Source: *Journal of Materials Engineering and Performance*, v 34, n 1, p 1-35, January 2025; **ISSN:** 10599495, **E-ISSN:** 15441024; **DOI:** 10.1007/s11665-024-09945-y; **Publisher:** Springer
Author affiliation: (1) School of Mechanical Engineering, Northwestern Polytechnical University, Xi'an; 710072, China (2) Key Laboratory of Road Construction Technology and Equipment of the Ministry of Education, Chang'an University, Xian; 710064, China (3) Key Laboratory of Ministry of Industry and Information Technology for High Performance Aeroengine, Xi'an; 710072, China (4) Shaanxi Key Laboratory of Gear Transmissions, Xi'an; 710072, China
Abstract: Laser surface treatment (LST) presents notable advantages such as the flexibility to process complex shapes, high material adhesion, and small heat-affected zone. The ongoing development and widespread adoption of LST have underscored its exceptional utility in gear surface modification. This paper offers a comprehensive review of the applications and simulations of prevalent LST techniques in gear surface modification, encompassing laser quenching, laser surface remelting, laser shock peening, laser surface alloying, laser cladding, laser texturing, and hybrid processes. This review systematically analyzes the published literature regarding LST applied to gears or gear materials. It concisely summarizes essential process parameters and their influence on the post-LST surface performance of gears and investigates how LST-induced alterations in the micro-geometric morphology of gear surfaces affect their overall performance. Beyond presenting the latest advancements in LST application to gears, this review is oriented toward providing guidance for future research in this specialized field. © ASM International 2024. (245 refs)
Main heading: Surface treatment
Controlled terms: Gears - Laser cladding - Laser heating - Laser materials processing - Remelting - Surface reconstruction
Uncontrolled terms: Application of laser - Complex shapes - Heat-affected zones - Hybrid processing - Laser quenching - Laser shock peening - Laser surface remelting - Laser surface treatment - Surface-modification - Treatment techniques
Classification Code: 201.4.1 Foundries - 208 Coatings, Surfaces, Finishes, Films and Deposition - 208.1 Coating Techniques - 601.2 Machine Components - 602 Mechanical Drives and Transmissions - 744.6 Laser Applications
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