

Table of Contents

Preface, Committee and Sponsors

Chapter 1: Stress Analysis – Diffraction Methods

Keynote Lecture: Residual Stress Gradient Analysis by Multiple Diffraction Line Methods C. Genzel, D. Apel, M. Klaus, M. Genzel and D. Balzar	3
Stress Measurement of an Austenitic Stainless Steel Foil by $\cos^2\chi$ Method Using Polychromatic Laboratory X-Rays Y. Akiniwa and T. Hiramura	19
Different Grain Interaction Models Used for Interpretation of Lattice Strain Data Collected Using Grazing Incidence X-Ray Diffraction M. Marciszko, A. Baczmański, M. Wróbel, W. Seiler, C. Braham and K. Wierzbanowski	26
Upgrade Activities on the E3 Residual Stress Neutron Diffractometer M. Boin and R.C. Wimpory	31
Analysis of Texture Depth Distribution by Energy-Dispersive Diffraction R.S. Coelho, M. Klaus and C. Genzel	36
Residual Stress Analysis by Energy-Dispersive Synchrotron Diffraction: Concepts for High Resolution Depth Profiling in Real Space T. Fuß, M. Meixner, M. Klaus and C. Genzel	44
Neutron Residual Strain Surface Scans - Experimental Results and Monte Carlo Simulations J.R. Kornmeier, J. Šaroun, J. Gibmeier and M. Hofmann	52
In Situ Biaxial Mechanical Testing at the Neutron Time-of-Flight Diffractometer POLDI J. Repper, M. Niffenegger, S. van Petegem, W. Wagner and H. van Swygenhoven	60
Influence of Shot-Peening Parameters on the Sub-Surface Residual Stress Profiles in Al-7075 Alloy Components D. Cecchin, C.L. Azanza Ricardo, M. D'Incau, M. Bandini and P. Scardi	66
Depth-Resolved Residual Stress Analysis with High-Energy Synchrotron X-Rays Using a Conical Slit Cell P. Staron, T. Fischer, J. Keckes, S. Schratter, T. Hatzenbichler, N. Schell, M. Müller and A. Schreyer	72

Chapter 2: Stress Analysis – Mechanical Methods

Modeling and Measurement of Residual Stresses along the Process Chain of Autofrettaged Components by Using FEA and Hole-Drilling Method with ESPI H. Brünnet, D. Bähre, T.J. Rickert and D. Dapprich	79
Mapping Multiple Components of the Stress Tensor Using the Contour Method F. Hosseinzadeh and P.J. Bouchard	87
Stress Measurements in Glass and Plastic by Optical Hole-Drilling M. Laakkonen, T.J. Rickert and L. Suominen	95
Measurement of Residual Stresses in the Cold-Rolled Fe-Ni-Mn/Invar Thermo-Bimetallic Plate H. Lille, J. Kő, J. Valgur, A. Ryabchikov, R. Reitsnik and R. Veinthal	101
Numerical and Experimental Study of the Plasticity Effect on Residual Stress Measurement Using Slitting Method A.H. Mahmoudi, S. Heydarian and K. Behnam	107
A Neural Networks Approach to Measure Residual Stresses Using Spherical Indentation A.H. Mahmoudi, M. Ghanbari-Matloob and S. Heydarian	114
An Almost User-Independent Evaluation Formalism to Determine Arbitrary Residual Stress Depth Distributions with the Hole-Drilling Method A. Nau, G.G. Feldmann, J.P. Nobre, W. Zinn and B. Scholtes	120
Evaluation of Residual Stresses Induced by Ultra-High-Speed Drilling in Aluminium Alloys J.P. Nobre, R. Guimarães, A.C. Batista, M.J. Marques, L. Coelho, A. Nau and B. Scholtes	128

Influence of the Interfacial Roughness on Residual Stress Analysis of Thick Film Systems by Incremental Hole Drilling	136
E. Obelode and J. Gibmeier	
Investigation of Residual Stresses in Flame Sprayed Ni-Based Wear Resistant Coatings by the Hole-Drilling and X-Ray Methods	144
A. Ryabchikov, H. Lille, R. Reitsnik, S. Toropov, A. Surženkov and P. Kulu	
Bending Test Rig for Validating the Hole Drilling Method Residual Stress Measurement	150
E. Valentini, A. Benincasa and C. Santus	
Measuring in-depth Residual Stress Gradients: The Challenge of Induction Hardened Parts	158
V. Savaria, F. Bridier and P. Bocher	
Technology and Equipment for Determination of Residual Stresses in Welded Structures Based on the Application of Electron Speckle-Interferometry	166
L. Lobanov, V. Pivtorak, V. Savitsky and G. Tkachuk	
Hole-Drilling Method for Residual Stress Measurement - Consideration of Elastic-Plastic Material Properties	174
D. von Mirbach	

Chapter 3: Stress Analysis – Other Methods

Application of the Eigenstrain Theory to Predict Residual Stress around Curved Edges after Laser Shock Peening	185
S. Coratella, M. Burak Toparli and M.E. Fitzpatrick	
Use of the Eigenstrain Concept for Residual Stress Analysis	193
V. Luzin	
Third Order Elastic Constants and Rayleigh Wave Dispersion of Shot Peened Aero-Engine Materials	201
M. Rjelka, M. Barth, S. Reinert, B. Koehler, J. Bamberg, H.U. Baron and R. Hessert	
An Attempt to Find an Empirical Model between Barkhausen Noise and Stress	209
A. Sorsa, M. Ruusunen, K. Leiviskä, S. Santa-Aho, M. Vippola and T. Lepistö	
Birefringent Residual Stress and Improved Injection Mold Design	217
J.C. Hanan	

Chapter 4: Instrumental Developments

XRD² Stress Measurement for Samples with Texture and Large Grains	227
B.B. He	
Alignment of a ¼-Circle Cradle for Reliable Residual Stress Measurements	235
A.C. Vermeulen	
Standard Sample Package for Calibration of X-Ray Stress Measurement	242
S. Yasukawa, T. Miyoshi, M. Yamamoto, T. Yamamoto and S. Ohya	

Chapter 5: Thin Films / Stress Gradients

Stress of Homogeneous and Graded Epitaxial Thin Films Studied by Full-Shape Analysis of High Resolution Reciprocal Space Maps	249
T. Ulyanenkova, A. Benediktovitch, M. Myronov, J. Halpin, S. Rhead and A. Ulyanenkova	
Diffraction Stress Analysis of Fiber Textured Ti Thin Films Undergoing hcp - fcc Phase Transformation	257
J. Chakraborty	
The Influence of Multilayer Design on Residual Stress Gradients in Ti/TiAlN Systems	264
U. Selvadurai, W. Tillmann, G. Fischer and T. Sprute	
Macroscopic Fracture Behaviour of CrN Hard Coatings Evaluated by X-Ray Diffraction Coupled with Four-Point Bending	272
M. Stefenelli, A. Riedl, J. Todt, M. Bartosik, R. Daniel, C. Mitterer and J. Keckes	
Characterisation of the Residual Stresses in HVOF WC-Co Coatings and Substrates	280
A.M. Venter, O.P. Oladijo, L.A. Cornish and N. Sacks	

Chapter 6: Microstructure, Local Stresses

Study of Stresses in Texture Components Using Neutron Diffraction

A. Baczmański, E. Gadalińska, S. Wroński, L. Le Joncour, B. Panicaud, M. François, C. Braham, V. Klosek and A.M. Paradowska

289

Macroscopic and Microscopic Determinations of Residual Stresses in Thin Oxide Dispersion Strengthened Steel Tubes

J.L. Béchade, L. Toualbi, S. Bosonnet, O. Castelnau and Y. de Carlan

296

Cementite Dissolution in Cold Drawn Pearlitic Steel Wires: Role of Dislocations

J. Chakraborty, T. Maity, M. Ghosh, G. Das and S. Chandra

304

In Situ Structural Evolution of Steel-Based MMC by High Energy X-Ray Diffraction and Comparison with Micromechanical Approach

G. Geandier, M. Dehmas, M. Mourot, E. Aeby-Gautier, S. Denis, O. Martin and N. Karnataka

313

Inter-Granular Phase Formation during Reactive Diffusion of Gallium with Al Alloy

J. Khoklova

321

Evolution of Residual Micro Phase and Orientation Dependent Stresses during Cold Wire Drawing

M. Kriška, J. Tacq, K. van Acker and M. Seefeldt

327

Thermal Stress Estimation of Tungsten Fiber Reinforced Titanium Composite by *In Situ* X-Ray Diffraction Method

N. Masayuki, H. Masashi, M. Tatsuya, J. Tian and H. Takao

335

Distribution of Residual Stresses in 1070 Single Phase Aluminium with Grain Size Gradient Formed by RBT Treatment

Y. Enomoto, T. Nishimura, H. Sato and S.I. Tanaka

343

Comparison of Internal and Residual Stresses Measured by Strain-Dip Test and XRD during High Temperature Deformation of Al-Mg Solid Solutions

H. Sato, Y. Enomoto, K. Omote and S.I. Tanaka

351

Study on Ductile Damage Progress of Aluminum Single Crystal Using Synchrotron White X-Ray

J. Shibano, M. Kiso, K. Kajiwara, T. Shobu, S. Miura and M. Kobayashi

358

Micro Stresses within Cu Bi-Crystal and Al Tri-Crystal after Plastic Deformation Observed by X-Ray and Neutron Diffraction

A. Shiro, N. Masayuki, M.R. Muslih, T. Okada and H. Takao

366

Characteristic Evolution of Residual Stress in Shape Memory Fe-Mn-Si-Cr Alloys

S. Suzuki, E.P. Kwon and S. Tanaka

374

Synchrotron Diffraction Study of the Cementite Phase in Cold Drawn Pearlitic Steel Wires

J. Tacq, M. Kriška and M. Seefeldt

380

Chapter 7: Manufacturing Processes

Residual Stress Development in Laser Machined PVD-Coated Carbide Cutting Tools

B. Breidenstein, C. Gey and B. Denkena

391

Prediction of the Distortions Caused by the Redistribution of the Residual Stresses During Machining Using FEM

X. Cerutti, S. Hassini, E. Duc and K. Mocellin

398

In Situ XRD Stress Analysis during Expansion of Stents

W. Kowalski, M. Dammer, F. Bakczewitz and O. Kessler

406

Sensitivity of Macro- and Micro-Residual Stress States of Steel Surfaces to Thermal Influences Caused by Grinding Burn and Laser Treatments

B. Eigenmann, A. Zösch and M. Seidel

412

Non-Destructive Residual Stress Analysis of Induction Hardened Components by Neutron and X-Ray Diffraction

J. Epp, T. Pirling and T. Hirsch

420

Residual Stresses in the Hot Sprues of as-cast Mg-Zn Alloys Investigated by STRESS-SPEC Neutron Diffractometer

W.M. Gan, Y.D. Huang, Z. Wang, N. Hort and M. Hofmann

428

Through-Thickness Stresses in Automotive Sheet Metal after Plane Strain Channel Draw T. Gnäupel-Herold, D.E. Green, T. Foecke and M. Iadicola	433
Interpretation of Diffraction Data from <i>In Situ</i> Stress Measurements during Biaxial Sheet Metal Forming T. Gnäupel-Herold, M. Iadicola, A. Creuziger, T. Foecke and L. Hu	441
The Influence of Chemical Composition on Residual Stresses in NiCoMo Alloy Deposits on 12 Ni Maraging Steel Z. Bergant and J. Grum	449
Simulation of the Roller Straightening Process with Respect to Residual Stresses and the Curvature Trend R. Kaiser, T. Hatzenbichler, B. Buchmayr and T. Antretter	456
Residual Stresses Profiles of Cladded Austenitic Stainless Steel Evaluated by X-Ray Diffraction and by Incremental Hole-Drilling Method M.J. Marques, A.C. Batista, L. Coelho, J.P. Nobre and A. Loureiro	464
Influence of Dry Cut and Tool Wear on Residual Stresses in High Speed Machining of Nickel-Based Superalloy R.L. Peng, J.M. Zhou, S. Johansson, A. Bellinius, V. Bushlya and J.E. Ståhl	470
Shaping of Ceramics Using Residual Stresses H. Höpfel and W. Pfeiffer	478
<i>In Situ</i> Strain Measurements during Casting Using Neutron Diffraction M. Reihle, M. Hofmann, U. Wasmuth, W. Volk, H. Hoffmann and W. Petry	484
Influence of Final Hand Polishing Process on Surface Residual Stress Field of Japanese Sword Y. Sakaida, H. Yoshida, S. Yashiro and T. Murai	492

Chapter 8: Mechanical Surface Treatment

3D Model of Shot Dynamics for Ultrasonic Shot Peening J. Badreddine, E. Rouhaud, M. Micoulaut, S. Remy, V. Desfontaine and P. Renaud	503
Mechanical Surface Treatment Technologies for Improving HCF Strength and Surface Roughness of Blisk-Rotors G.G. Feldmann and T. Haubold	510
Surface Modification Analysis after Shot Peening of AA 7075 in Different States S. Žagar and J. Grum	519
Residual Stress Depth Distribution after Piezo Peening of Quenched and Tempered AISI 4140 F. Liener, J. Hoffmeister and V. Schulze	526
Influence of Shot Peening Parameters on Residual Stresses in Flake and Vermicular Cast Irons M. Lundberg, R.L. Peng, M. Ahmad, T. Vuoristo, D. Bäckström and S. Johansson	534
Graphite Morphology's Influence on Shot Peening Results in Cast Irons M. Lundberg, R.L. Peng, M. Ahmad, D. Bäckström, T. Vuoristo and S. Johansson	542
The Influence of Shot Peening Process on the Residual Stress and Microstructure in Deformed Surface Layer of S30432 Austenitic Stainless Steel K. Zhan, C.H. Jiang and H. Pan	550
The Evolution of Residual Stress and Microstructure in Shot Peened S30432 Austenitic Stainless Steel at High Temperatures K. Zhan, C.H. Jiang and H. Pan	557
Characteristics of Residual Stress by Water-Jet Peening K. Suzuki, T. Shobu and A. Shiro	564
Corrosion and Fatigue of AL-Alloys AA359.0 and AA6060 in Different Surface Treatment States K. Timmermann, W. Zinn and B. Scholtes	572
Generation and Determination of Compressive Residual Stresses of Short Penetration Depths R. Weingärtner, J. Hoffmeister and V. Schulze	580

Chapter 9: Welding and Joining

The Investigation of the Triaxial Residual Stress in the Friction Stir Welded Lap Joint Using Neutron Diffraction	
M. Bach, A. Merati, M.A. Gharghouri, R. Rogge, R. Bell and X. Wang	589
Automatic Meshing Method for Optimisation of the Fusion Zone Dimensions in Finite Element Models of Welds	
K. Decroos, C. Ohms, R. Petrov, M. Seefeldt, F. Verhaeghe and L. Kestens	597
Welding Residual Stresses in Tubular Joints	
M. Farajian, T. Nitschke-Pagel and K. Dilger	605
Residual Stress Engineering in Fatigue Resistant Welds	
M. Farajian, Z. Barsoum and A. Kromm	613
Residual Stress in Steel Fusion Welds Joined Using Low Transformation Temperature (LTT) Filler Material	
J. Gibmeier, E. Obelode, J. Altenkirch, A. Kromm and T. Kannengiesser	620
An Experimental Comparison of Weld-Induced Residual Stresses Using Different Stainless Steel Filler Metals Commonly Used for Hydraulic Turbines Manufacturing and Repair	
S. Godin, D. Thibault and J.B. Lévesque	628
Effects of Residual Stresses on the Fatigue Performance of Welded Steels with Longitudinal Stiffeners	
J. Hensel, T. Nitschke-Pagel, K. Dilger and S. Schönborn	636
In Situ Measurement of Thermal Strain during Fusion Welding	
U. Reisgen, C. Geffers, R. Sharma and J. von der Heydt	644
Numerical Analysis of the Effect of Phase Transformation on Residual Stresses in an Autogenous Beam Edge Weld	
M.M. Joosten	652
Effect of Martensitic Phase Transformation on Stress Build-up during Multilayer Welding	
A. Kromm and T. Kannengiesser	660
Identification of Weld Residual Stresses Using Diffraction Methods and their Effect on Fatigue Strength of High Strength Steels Welds	
L. Mraz, L. Karlsson, P. Mikula and M. Vrána	668
Identification of Load Induced Inhomogeneous Plastic Deformations in Aluminium Welds by Diffraction Methods	
M. Workowski, T. Nitschke-Pagel and K. Dilger	675
Predicting Residual Stresses in Friction Stir Welding of Aluminum Alloy 6061 Using an Integrated Multiphysics Model	
M. Nourani, A.S. Milani, S. Yannacopoulos and C.Y. Yan	682
An Abaqus Extension for 3-D Welding Simulations	
M. Shubert and M. Pandheeradi	690
Neutron Diffraction Investigation of Residual Stresses Induced in Niobium-Steel Bilayer Pipe Manufactured by Explosive Welding	
Y. Taran, A.M. Balagurov, B. Sabirov, V. Davydov and A.M. Venter	697

Chapter 10: Material Loading, Damage and Component Life

Wear and Surface Residual Stress Evolution on Twin-Disc Tests of Rail/Wheel Steels	
A.C. Batista, D.F.C. Peixoto, J.P. Nobre, L. Coelho, D.M. Ramos, L.A.A. Ferreira and P.M.S.T. de Castro	707
Finite Element Analysis of the Rolling-Sliding Contact of vibrationally Loaded Bearings Based on a Micro Friction Model	
A. Konrad, W. Nierlich and J. Gegner	714
Service Loading Analysis of Wind Turbine Gearbox Rolling Bearings Based on X-Ray Diffraction Residual Stress Measurements	
J. Gegner and W. Nierlich	723

An Experimental Procedure to Determine the Interaction between Applied Loads and Residual Stresses	
G. Horne, M.J. Peel, D.G. Hattingh, T. Connolley, M. Hart, J. Kelleher, S.Y. Zhang and D.J. Smith	733
Residual Stresses in Rail-Ends from the in-Service Insulated Rail Joints Using Neutron Diffraction	
V. Luzin, C. Rathod, D. Wexler, P. Boyd and M. Dhanasekar	741
Impact of Residual Stresses on the Fatigue Behavior of a Nickel-Based Superalloy	
A. Morancais, M. Fevre, P. Kanoute, S. Kruch and M. Fran�ois	747
Residual Stresses in Roller Bearing Components	
H. Schlicht and H. Vettters	755