Chapter: Invited Session
Optically Generated sub-100 nm Structures for Biomedical and Technical Applications
K. König, A. Ostendorf ................................................................. 1

Chapter: Macro Processing
Sub-Chapter: Macro Welding, Brazing & Soldering
Laser Beam Welding of Aluminum Alloys under the Influence of an Electromagnetic Field
A. Schneider, V. Avilov, A. Gumeyuk, M. Rethmeier ................................................................. 4
Failure Behavior of Aluminum-Titanium Hybrid Seams within a Novel Aluminum-CFRP Joining Concept
P. Wozeschke, J. Schumacher ................................................................. 12
Spatter Formation in Laser Welding with Beam Oscillation
M. Schweier, J.F. Heins, M.W. Haubold, M.F. Zaeh ................................................................. 20
Electrochemistry Corrosion Properties of Pulsed Laser Welding Hastelloy C-276
G. Ma, F. Niu, D. Wu, Y. Qu ................................................................. 31
Effect of Nd:YAG Laser Welding Parameters on the Hardness of Lap Joint: Experimental and Numerical Approach
C. Seang, A.K. David, E. Ragneau ................................................................. 38
Inductive Preheating in Laser Beam Welding of Multimaterial Joints of 22MnB5 and AA6016
H. Kügler, F. Vollertsen ................................................................. 41
Influence of Laser Wavelength on Melt Bath Dynamics and Resulting Seam Quality at Welding of Thick Plates
Experimental Investigation of Laser Transmission Welding of Thermoplastics with Part-Adapted Temperature Fields
M. Devrient, M. Kern, P. Jaeschke, U. Stute, H. Haferkamp, M. Schmidt ................................................................. 59
Laser Transmission Welding of Thermoplastics with Dual Clamping Devices
M. Devrient, B. Knoll, R. Geiger ................................................................. 70
Interaction Effects between Laser Beam and Plasma Arc in Hybrid Welding of Aluminum
F. Möller, C. Thomy ................................................................. 81
Investigation of the Formation of Nanoparticles during Laser Remote Welding
T. Scholz, K. Dickmann, A. Ostendorf ................................................................. 90
Thermal Joining of Thermoplastic Metal Hybrids by Means of Mono- and Polychromatic Radiation
P. Amend, S. Pfindel, M. Schmidt ................................................................. 98
Laser Welding of Large Scale Stainless Steel Aircraft Structures
D. Reitemeyer, V. Schultz, F. Syassen, T. Seefeld, F. Vollertsen ................................................................. 106
High-Speed X-Ray Analysis of Spatter Formation in Laser Welding of Copper
A. Heider, J. Sollinger, F. Abt, M. Boyle, R. Weber, T. Graf ................................................................. 112
Guidelines in the Choice of Parameters for Hybrid Laser Arc Welding with Fiber Lasers
I. Eriksson, J. Powell, A. Kaplan ................................................................. 119
Laser Brazing of Aluminum with a New Filler Wire AlZn13Si10Cu4
Z. Tang, T. Seefeld, F. Vollertsen ................................................................. 128
Improved Continuous Tube Welding Due to Unique Process Sensor System and Process Control
F. Dorsch, D. Pfitzner, H. Braun ................................................................. 137
Autogeneous Laser and Hybrid Laser Arc Welding of T-joint Low Alloy Steel with Fiber Laser Systems
A. Unt, E. Lappalainen, A. Salminen ................................................................. 140
Laser Welding Head Tailored to Tube-Sheet Joint Requirements for Heat Exchangers Manufacturing
A. Vandewynckle, E. Vaamonde, M. Fontán, P. Herwig, A. Mascioletti ................................................................. 144
Stress-Minimized Laser Soldering of h-Pattern Multicrystalline Silicon Solar Cells
S. Britten, A. Olowinsky, A. Gillner ................................................................. 153
Remote Laser Welding of Multi-Alloy Aluminum at Close-Edge Position
D. Weller, C. Bezençon, P. Stritt, R. Weber, T. Graf ................................................................. 164
Long Term Stability of Laser Joined Plastic Metal Parts
A. Roensier, A. Olowinsky, A. Gillner ................................................................. 169
Laser Transmission Welding of White Thermoplastics with Adapted Wavelengths
V. Manuschkin, A. Roensier, M. Aden ................................................................. 172
Effects of Diode Laser Superposition on Pulsed Laser Welding of Aluminum
J.P. Bergmann, M. Bielenin, M. Stambke, T. Feustel, P.v. Witzendorf, J. Hermsdorf ................................................................. 180
Influence of Aluminum Coating and Diffusion Affecting Additives on Dissimilar Laser Joining of Steel and Aluminum
J.P. Bergmann, M. Stambke, S. Schmidt ................................................................. 190
### Contents

New Trends in Laser within the Process Chain of Hotforming Production
J. Bührle, M. Fritz ................................................................. 421

Hole Formation Process in Ultrashort Pulse Laser Percussion Drilling
S. Döring, T. Ullsperger, F. Heisler, S. Richter, A. Tünnermann, S. Nolte ........................................ 424

**Sub-Chapter: Macro Simulation, Sensing & Control**

Simulation and Realization of a Focus Shifting Unit using a Tunable Lens for 3D Laser Material Processing
G. Eberle, V. Chiron, K. Wegener ......................................... 434

Nd:YAG Laser Welding of Sheet Metal Assembly: Transformation Induced Volume Strain Affect on Elastoplastic Model
C. Seang, A.K. David, E. Ragneau ........................................ 441

Analytical Modeling of the Keyhole Including Multiple Reflections for Analysis of the Influence of Different Laser Intensity Distributions on Keyhole Geometry
J. Volpp, F. Vollertsen ....................................................... 453

Correlation between the Keyhole Depth and the Frequency Characteristics of Light Emissions in Laser Welding
L. Mrňa, M. Šarbort, Š. Reufka, P. Jedlička .............................. 462

Thermal and Fluid Flow Characteristics and their Relationships with Porosity in Laser Welding of AA5083
B. Chang, C. Allen, J. Blackburn, P. Hilton .......................... 471

X-Ray and Optical Videography for 3D Measurement of Capillary and Melt Pool Geometry in Laser Welding
M. Boley, F. Abt, R. Weber, T. Graf ........................................ 481

Spectral Analysis of Laser Processing of Carbon Fiber Reinforced Plastics
M. Jarwitz, V. Onuseit, R. Weber, T. Graf ............................... 489

A Novel Thermal Sensor Applied for Laser Materials Processing
H. Köhler, V. Jayaraman, D. Brosch, F.X. Hutter, T. Seefeld .................................................. 495

Detectability of Penetration based on Weld Pool Geometry and Process Emission Spectrum in Laser Welding of Copper
A. Oezmert, A. Drenker, V. Nazery ...................................... 502

Remote Optical Detection of the Fusion State in Laser Deep Penetration Welding
F. Tenner, C. Brock, R. Hohenstein, Z. Zalevsky, M. Schmidt .......................... 508

Simulation of the Melting Volume in Thin Molybdenum Films as a Function of the Laser Pulse Duration
J. Sotrop, M. Domke, A. Kersch, H.P. Huber ................................ 513

Hardware based Analysis and Process Control for Laser Brazing Applications
M. Unger, R. Rolser, P. Abels ............................................ 517

On-Line Characterization of Gold Nanoparticles Generated by Laser Ablation in Liquids
M. Maciulevičius, A. Vinčiūnas, M. Brikas, A. Butsen, N. Tarasenka, N. Tarasenko, G. Račiuikaitis ........................ 524

Detection of Weld Defects by High Speed Imaging of the Vapor Plume
C. Brock, F. Tenner, F. Klinspß, R. Hohenstein, M. Schmidt .......................... 532

**Sub-Chapter: Advanced Beam Sources & System Engineering**

Polygon Scanner System for Ultra Short Pulsed Laser Micro-Machining Applications
R. De Loor .................................................................... 537

Light Management in Transparent Conducting Oxides by Direct Fabrication of Periodic Surface Arrays
S. Eckhardt, C. Sachse, A.F. Lasagni ..................................... 545

Laser Cutting with Direct Diode Laser

Particle Filtration for Ultra Fast Laser Processing
S. Jakschik, D. Kesslau ...................................................... 559

**Chapter: Micro Processing**

**Sub-Chapter: Micro Cutting and Joining**

Laser Processing of Carbon Fiber Reinforced Polymer Composite for Optical Fiber Guidelines
M.S.F. Lima, J.M.S. Sakamoto, J.G.A. Simoes, R. Riva .................................................. 565

Investigation of Copper/Gold Laser Seam Welding for Targets Manufacturing
R. Boudrenet, I. Geoffray, C. Chicane, V. Brunet .................................................. 574

X-Lase CoreScriber, Picosecond Fiber Laser Tool for High-Precision Scribing and Cutting of Transparent Materials
S. Kriventš, T. Amberla, T. Konnunaho, J. Kangastupa, J. Sillanpää ........................................ 582

Approaches to Increase Process Efficiency in Laser Micro Welding
A. Patserger, J. Bliedtner, J.P. Bergmann ................................ 585

Dicing of Thin Si Wafers with a Picosecond Laser Ablation Process
C. Fornaroli, J. Holtkamp, A. Gillner ..................................... 596

Laser Processing of Coarse Grain Polycrystalline Diamond (PCD) Cutting Tool Inserts using Picosecond Laser Pulses
C. Dold, M. Henerichs, P. Gilgen, K. Wegener .................................................. 603

Experimental Study of Diode Laser Cutting of Silicon by Means of Water Assisted Thermally Driven Separation Mechanism
P. Romero, N. Otero, I. Coto, C. Leira, A. González .................................................. 610
### Picosecond Laser Induced Selective Removal of Functional Layers on CIGS Thin Film Solar Cells

K. Ratautas, M. Gedvilas, G. Račiukaitis

### Laser Trepnaning of Stainless Steel


### Micromachining of CFRP with Ultra-Short Laser Pulses

M. Fujita, T. Somekawa, N. Miyana  

### Sub-Chapter: Micro Structuring and Nano Processing

#### Thermodynamic Investigations on the Laser Ablation Rate of Silicon over Five Fluence Decades

V. Schütz, U. Stute, A. Horn

#### Analysis of Irradiation Processes for Laser-induced Periodic Surface Structures

J. Eichstädt, A.J. Huis in ’t Veld

#### Laser-Beam Helical Drilling of High Quality Micro Holes

C. Fornaroli, J. Holtkamp, A. Gillner

#### On Line Sensing of Ultrafast Laser Microdrilling Processes by Optical Feedback Interferometry

F.P. Mezzapesa, L.L. Columbo, A. Ancona, M. Dabbicco, V. Spagnolo, M. Brambilla, P.M. Lugarà, G. Scamarcio

#### Varying the Geometry of Laser Surface Microtexturing to Enhance the Frictional Behavior of Lubricated Steel Surfaces

F.P. Mezzapesa, M. Scaraggi, G. Carbone, D. Sorgente, A. Ancona, P.M. Lugarà

#### The Role of Temporal Energy Input in Laser Micro Machining using Nanosecond Pulses

S. Eisele, D. Wu, P. Galarneau, M. Schmidt

#### Comparative Analysis of Laser Generated P2 Processes for a-Si:H Modules and their Electrical Influence on the Final Device

J.J. García-Ballesteros, I. Torres, M. Morales, D. Canteli, J.D. Santos, J. Cárate, J.J. Gandía, C. Molpeceres

#### Parallel Microstructuring using Femtosecond Laser and Spatial Light Modulator

M. Silvennoinen, J. Kaakkunen, K. Paivasara, P. Vahima

#### Influence of the Repetition Rate and Pulse Duration on the Incubation Effect in Multiple-Shots Ultrafast Laser Ablation of Steel

F. Di Niso, C. Gaudioso, T. Sibillano, F.P. Mezzapesa, A. Ancona, P.M. Lugarà

#### Micron and Sub-Micron Gratings on Glass by UV Laser Ablation

J. Meinertz, T. Fricke-Begemann, J. Ihlemann

#### All Fiber Laser Scribing of Cu(In,Ga)Se2 Thin-Film Solar Modules

A. Burn, M. Muralt, S. Pilz, V. Romano, R. Witte, B. Frei, S. Buecheler, S. Nishiwaki, L. Krainer

#### PCB Drilling with High Power Picosecond Lasers

S. Luzius, M. Sailer, C. Siebert, S. Russ

#### Fabrication of Micro-Size Structures using Scanned Interference Pattern

S. Indrišiš, B. Voisiat, G. Račiukaitis

#### Physical Mechanisms during fs Laser Ablation of Thin SiO2 Films

S. Rapp, M. Domke, M. Schmidt, H.P. Huber

#### Selective Front Side Patterning of CZTS Thin-Film Solar Cells by Picosecond Laser Induced Material Lift-Off Process

P. Gecys, E. Markauskas, G. Račiukaitis, I. Repins, C. Beall

#### Nanosecond Laser Lift-Off of a Copper-Indium-Diiselenide Thin Film at a Wavelength of 1342 nm

R. Moser, M. Domke, G. Marowsky, H.P. Huber

#### Experimental and Analytical Investigation of Cemented Tungsten Carbide Ultra-Short Pulse Laser Ablation

J.P.C. Urbina, C. Daniel, C. Emmelmann

#### Fibre Laser Texturing for Surface Functionalization

A.G. Demir, P. Maresa, B. Previtali

#### Picosecond Laser Induced Selective Removal of Functional Layers on CIGS Thin Film Solar Cells

A. Lemke, D. Ashkenasi, H.J. Eichler

#### Formation Dynamics of Ultra-Short Laser Induced Micro-Dots in the Bulk of Transparent Materials

A. Mermillod-Blondin, D. Ashkenasi, A. Lemke, M. Schwagmeier, A. Rosenfeld

#### Glass Nanofibers from Fragile Melts Produced by Laser Spinning

O. Dieste, J. Penide, F. Quintero, A. Riveiro, F. Lusquiños, J. Pou

#### Synthesis of Titanium Oxide Nanoparticles by Ytterbium Fiber Laser Ablation

M. Boutinguiza, J. de Val, A. Riveiro, F. Lusquiños, F. Quintero, R. Comesaña, J. Pou

#### From fs to Sub-ns: Dependence of the Material Removal Rate on the Pulse Duration for Metals

B. Neuenwander, B. Jaeggi, M. Schmidt

#### Femtosecond Laser Ablation of ITO/ZnO for Thin Film Solar Cells

S.A. Fernandes, B. Schoeps, K. Kowalick, R. Nett, C. Esen, M. Pickshaus, A. Ostendorf

### Sub-Chapter: Laser Additive Manufacturing

#### Surface Finish after Laser Metal Deposition

M. Rombouts, G. Maes, W. Hendrix, D. Delarbre, F. Moitmans

#### Investigations on Manufacturability and Process Reliability of Selective Laser Melting

H. Krauss, M.F. Zaeh
### Contents

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlling the Microstructure of Hastelloy-X Components Manufactured by Selective Laser Melting</td>
<td>816</td>
</tr>
<tr>
<td>Micro-structure and Mechanical Properties of Nano-TiC Reinforced Inconel 625 Deposited using LAAM</td>
<td>821</td>
</tr>
<tr>
<td>G. Bi, C.N. Sun, M.L. Nai, J. Wei</td>
<td>821</td>
</tr>
<tr>
<td>Temperature Profile and Imaging Analysis of Laser Additive Manufacturing of Stainless Steel</td>
<td>828</td>
</tr>
<tr>
<td>M. Islam, T. Purtonen, H. Piili, A. Salminen, O. Nyrhila</td>
<td>828</td>
</tr>
<tr>
<td>Microstructure and Properties of Selective Laser Melted High Hardness Tool Steel</td>
<td>836</td>
</tr>
<tr>
<td>F. Feuerhahn, A. Schulz, T. Seefeld, F. Vollertsen</td>
<td>836</td>
</tr>
<tr>
<td>Verification of Structural Simulation Results of Metal-based Additive Manufacturing by Means of Neutron Diffraction</td>
<td>842</td>
</tr>
<tr>
<td>A. Streek, P. Regenfuss, H. Exner</td>
<td>851</td>
</tr>
<tr>
<td>Numerical Simulation and Comparison of Powder Jet Profiles for Different Types of Coaxial Nozzles in Direct Material Deposition</td>
<td>863</td>
</tr>
<tr>
<td>I. Kovaleva, O. Kovalev, A. Zaitsev, I. Smurov</td>
<td>863</td>
</tr>
<tr>
<td>Laser Additive Manufacturing of Gas Permeable Structures</td>
<td>866</td>
</tr>
<tr>
<td>C. Klahn, F. Bechmann, S. Hofmann, M. Dinkel, C. Emmelmann</td>
<td>866</td>
</tr>
<tr>
<td>Sub-Chapter: Simulation, Sensing &amp; Control</td>
<td></td>
</tr>
<tr>
<td>Simulation of Laser Beam Melting of Steel Powders using the Three-Dimensional Volume of Fluid Method</td>
<td>874</td>
</tr>
<tr>
<td>F.-J. Gürtler, M. Karg, K.-H. Leitz, M. Schmidt</td>
<td>874</td>
</tr>
<tr>
<td>Automated Process Initialization of Laser Surface Structuring Processes by Inline Process Metrology</td>
<td>880</td>
</tr>
<tr>
<td>R. Schmitt, G. Mallmann, K. Winands, M. Pothen</td>
<td>880</td>
</tr>
<tr>
<td>Thermoelastic Residual Stresses and Deformations at Laser Treatment</td>
<td>889</td>
</tr>
<tr>
<td>A.V. Gusarov, I.S. Malakhova-Ziablova, M.D. Pavlov</td>
<td>889</td>
</tr>
<tr>
<td>Optical In-Process Temperature Monitoring of Selective Laser Melting</td>
<td>897</td>
</tr>
<tr>
<td>Y. Chivel</td>
<td>897</td>
</tr>
<tr>
<td>Monitoring of Focus Position during Laser Processing based on Plasma Emission</td>
<td>904</td>
</tr>
<tr>
<td>D. Diego-Vallejo, D. Ashkenasi, H.J. Eichler</td>
<td>904</td>
</tr>
<tr>
<td>A. Mermillod-Blondin, D. Ashkenasi, A. Lemke, A. Rosenfeld</td>
<td>912</td>
</tr>
</tbody>
</table>