

# Proceedings

Fraunhofer Direct Digital Manufacturing  
Conference  
Berlin, March 15-16, 2023

# DDMC 2023

6th Fraunhofer Direct Digital Manufacturing Conference

Organized by the Fraunhofer Additive Manufacturing Alliance, the bi-annual Direct Digital Manufacturing Conference brings together researchers, educators and practitioners from around the world. The conference covers the entire range of topics in additive manufacturing, starting with methodologies, design and simulation, right up to more application-specific topics, e.g. from the realm of medical engineering and electronics.

**Contact:**

Fraunhofer Institute for Machine Tools and Forming Technology IWU  
Noethnitzer Strasse 44  
01187 Dresden  
Germany  
Phone +49 351 4772-2136  
info@additiv.fraunhofer.de  
www.additiv.fraunhofer.de

**Bibliographic information of the German National Library:**

The German National Library has listed this publication in its Deutsche Nationalbibliografie; detailed bibliographic data is available on the internet at [www.dnb.de](http://www.dnb.de).

ISBN 978-3-8396-1895-0

**© Fraunhofer Verlag, 2023**

Nobelstrasse 12  
70569 Stuttgart  
Germany  
verlag@fraunhofer.de  
www.verlag.fraunhofer.de

is a constituent entity of the Fraunhofer-Gesellschaft, and as such has no separate legal status.

Fraunhofer-Gesellschaft zur Förderung  
der angewandten Forschung e.V.  
Hansastraße 27 c  
80686 München  
Germany  
www.fraunhofer.de

All rights reserved; no part of this publication may be translated, reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the written permission of the publisher.

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. The quotation of those designations in whatever way does not imply the conclusion that the use of those designations is legal without the consent of the owner of the trademark.

# Table of Contents

## Session 1.1: Powders

<b>Influence of the Humidity at Rheological Properties by Quality Control of Micro Powders .....</b>	<b>13</b>
<i>Jens Otto Woytkowiak, Robby Ebert, Tim Protzmann</i>	
<b>Influence Analysis of Individual Powder Properties on L-PBF Process Capability.....</b>	<b>20</b>
<i>Philipp Kohlwes, Ina Ludwig, Arwin Kouhestani-Farouji, Dirk Herzog, Claus Emmelmann</i>	

## Session 1.2: Materials (Metals)

<b>AlSiMg0.6 Aluminium Alloy for Automotive Industry: Casting vs. PFB-LB/M .....</b>	<b>27</b>
<i>Irina Smolina, Konrad Gruber, Karol Kobiela, Michal Karoluk, Piotr Gruber, Tomasz Kurzynowski</i>	
<b>Production of Nickel-based Superalloy Parts by Using the MoldJet® Technology.....</b>	<b>33</b>
<i>Robert Teuber, Sebastian Riecker, Thomas Weißgärber, Antti Virta, Andreas Schmid</i>	

## Session 1.3: Materials (Polymers and composites)

<b>3D Printing of Lightweight „All-Polyethylene Single Component“ Composite Materials Designed for Circularity .....</b>	<b>39</b>
<i>Raimund Jaeger, Bernadette Schlüter, Christof Koplín, Jörg Hohe, Carl Schirmeister, Timo Hees, Rolf Mülhaupt</i>	
<b>Additive Manufacturing of Electrically Conductive TPE Material Using ARBURG Plastic Freeforming: Printability, Properties and Integration .....</b>	<b>44</b>
<i>Stefan Pfeffer, Patrick Springer, Tobias Herrmann, Oliver Refle, Simon Leitl, Martin Neff</i>	
<b>Analytical Model for the Prediction of Young`s Moduli of Fused Filament Fabrication Structures with Variable Ply Layups.....</b>	<b>52</b>
<i>Marlies Springmann, Peter Middendorf</i>	

## Session 2.1: Metal Technologies – L-PBF I

<b>Additive Manufacturing and Mechanical Investigations of Novel Biomedical Ti/Nb/Ta Alloys .....</b>	<b>59</b>
<i>Bahr Fayyazi, Jan Johannsen, Melanie Stenzel, Markus Weinmann</i>	
<b>Statistical Modelling of the laser_Material Interaction of Ti-6Al-4V During Laser powder Bed Fusion.....</b>	<b>65</b>
<i>Florian Bitter, Thomas Toepfel, Robert Kühne, Juliane Thielsch, Welf-Guntram Drossel</i>	

## Session 2.3: Multimaterial Technologies

<b>Evaluation of the Material Combination Tungsten (W) - CW106C (CuCr1Zr) for Additive Manufacturing by laser-based Powder Bed Fusion (PBF-LB/M)</b> .....	72
<i>Thomas Bareth, Armin Rieser, Maximilian Binder, Alexander von Müller, Robert Lürbke, Christian Seidel, Georg Schlick</i>	
<b>Multi-material Additive Manufacturing Hybrid Technology to Obtain Realistic Surgical Models</b> .....	78
<i>Felip Fenollosa-Artés, Pamela Lustig-gainza, Arnau valls-esteve, Lucas Krauel, Louison Poudelet, Laura Calvo-Duarte</i>	
<b>Additive Manufacturing of Strain Gauges by Laser-Based Powder Bed Fusion</b> .....	84
<i>Christoph Singer, Maximilian Binder, Georg Josef Schlick, Johannes Schilp</i>	

## Session 3.1: Metal Technologies – L-PBF II

<b>Influence of Scan Vector Orientation on Material Characteristics and Part Quality in PBF-LB/M</b> .....	92
<i>Thomas Bielefeld, Jan-Florian Käter</i>	
<b>Investigation of the Influence of the Substrate Temperature Variation on Crack Formation by an Implemented Movable Local Heating System in the Laser Powder Bed Fusion Process</b> .....	100
<i>Marco Alois Rudolf, Martin Leuterer, Sebastian Edelhäuser, Matthias Goldammer, Stefan Kleszczynski, Gerd Witt</i>	

## Session 3.2: Fuctionalization in AM

<b>Additive Manufacturing of Functionalized Glass Components</b> .....	106
<i>Jochen Schilm, Tassilo Moritz, Dörte Wagner, Eric Schwarzer-Fischer, Steven Weingarten, Uwe Scheithauer</i>	
<b>Thick-Film Technology - A Way for High Complex Ceramic AM Components</b> .....	111
<i>Lars Rebenklau, Henry Barth, Uwe Scheithauer, Paul Gierth, Eric Schwarzer-Fischer, Johannes Drechsel</i>	

## Session 4.1: Industrialization and Smart Production

<b>Biologically Inspired Structures for Creating Complex Wall Geometries</b> .....	117
<i>Stefan Holtzhausen, Alexander Seidler, Uwe Scheithauer, Eric Schwarzer-Fischer, Hajo Wiemer, Kristin Paetzold</i>	
<b>Automated Post-Processing of Additively Manufactured Ti5553-Components Using Robot-Guided Blasting</b> .....	122
<i>Eckart Uhlmann, Thomas Braun, Christian Lahoda</i>	

## Session 4.3: Production Use Cases

Potential of Densified Binder Jetter Gears Regarding Tooth Root Load Capacity .....	129
<i>Lukas Klee, Jens Brimmers, Thomas Bergs</i>	

## Session 5.1: Simulation

Simulation of the Laser Powder Bed Fusion Process with a Holistic Workflow .....	136
<i>Bastien Dietemann, Tim Najuch, Shoya Mohseni-Mofidi, Alexander Wessel, Alexander Butz, Claas Bierwisch</i>	

## Session 6.1: Printed Electronics I

Application of Magneto-responsive Materials in 4D Printing .....	143
<i>Stefan Junk, Daniel Kehret, Henning Einloth</i>	
Printed Electronics on 3D - Prospects and Effects of Inline IR Treatment for Robot Guided Inkjet Printing of Conductive Patterns .....	149
<i>Robert Thalheim, Dana Mitra, Anne-Marie Kröher, Ralf Zichner</i>	

## Posters

<b>Analysis of the Machine Capability of Low-Cost FLM Printers Using ABS Filament .....</b>	<b>156</b>
<i>Carsten Schmidt, Patricia Kaplik, Rainer Griesbaum, Florian Finsterwalder, Jan T. Sehr</i>	
<b>Potential of Contactless Support Structures for Improving the Part Quality of AISi10Mg PBF-LB Parts .....</b>	<b>162</b>
<i>Steffen Kramer, Kai Drechsel, Michael Jarwitz, Volker Schulze, Frederik Zanger</i>	
<b>Process Digitalization for Deposited Geometries in Laser Metal Deposition.....</b>	<b>168</b>
<i>Bohdan Vykhitar, Sebastian Hartmann, Malte Buhr, Daniel Regulin, Markus Kogel-Hollacher, Ingomar Kelbassa</i>	
<b>3D-Topographic Powder Layer Condition Monitoring for Improved L-PBF Process.....</b>	<b>174</b>
<i>Dennis Jutkuhn, Xuan Thanh Duong, Torben Dorbandt, Claus Emmelmann</i>	
<b>Acceleration of Digital Innovations and Products by Creating a Cyber Physical Production System Engineering Network (CEN) in the Additive Manufacturing Production Environment.....</b>	<b>180</b>
<i>Fabian Tieck, David Hoffmann, Arndt Lüder</i>	
<b>Thermal Optimization of Injection Molds Using Functionally Graded Materials.....</b>	<b>186</b>
<i>Thore Gericke, Lisa Marie Rickerts, Alexander Mattes, Tassilo-Maria Schimmelpfennig</i>	
<b>Hybridization of Materials and Technologies for the Manufacturing of Highly Functionalized and Reliable Ceramic Components for Applications Even Under Harsh Conditions.....</b>	<b>191</b>
<i>Uwe Scheithauer, Lars Rebenklau, Eveline Zschippang, Johannes Abel, Steven Weingarten, Eric Schwarzer-Fischer, Henry Barth</i>	