

Functionally Graded Materials in Industrial Mass Production Fundamentals

Werner Homberg
Dirk Biermann
Hans-Peter Heim

Functionally Graded Materials in Industrial Mass Production

Fundamentals

Edited by

Prof. Werner Homberg, University of Paderborn

Prof. Dirk Biermann, Dortmund University of Technology

Prof. Hans-Peter Heim, University of Kassel

All rights reserved.

No part of this publication may be reproduced or transmitted
by any means, electronic, mechanical, photocopying or otherwise
without the prior permission of the publisher.

© **2013**

Verlag Wissenschaftliche Scripten

Kaiserstrasse 32, 08209 Auerbach, Germany

info@verlag-wiss-scripten.de

www.verlag-wiss-scripten.de

ISBN: 978-3-942267-92-2

Table of Contents

1	Introduction.....	7
2	Production Technology for the Manufacture of Functionally Graded Parts.....	9
2.1	Graded Structures in Polymers <i>Volker Schöppner, Hans-Peter Heim, Andrea Wibbeke, Angela Ries and Björn Rohde</i>	11
2.2	Forming Technology..... <i>Kurt Steinhoff, Ursula Weidig, Erman Tekkaya, Ahmet Güzel, Andreas Jäger, Werner Homberg and Benjamin Lossen</i>	43
2.3	Machining Technology <i>Dirk Biermann, Andreas Zabel and Marcel Tiffe</i>	77
2.4	In-Process Production and Application of Horizontally and Vertically Graded Microstructures of Tools Using PVD and Thermal Spray Processes <i>Wolfgang Tillmann, Leif Hagen and Markus Dildrop</i>	83
2.5	Materials Characterization in Functionally Graded Workpieces <i>Martin Joachim Holzweissig and Hans Jürgen Maier</i>	93
3	Simulation Technology.....	99
3.1	Rheology and CFD of Polymer Melts..... <i>Ammar Al-Baldawi, Hogenrich Damanik, Stefan Turek and Olaf Wünsch</i>	101
3.2	Modeling and Simulation of Solid Materials <i>Thorsten Bartel, Alexander Bartels, Ulrich Ehlenbröcker, Rolf Mahnken, Andreas Menzel, Jörn Mosler, Richard Ostwald, Andreas Schneidt and Michael Wolff</i>	113
3.3	Electrothermal Simulation of Inductive Heating Processes <i>Tobias Gleim, Detlef Kuhl and Bettina Schröder</i>	129
3.4	Thermal Fluid-Structure-Interaction <i>Philipp Birken, Tobias Gleim, Detlef Kuhl and Andreas Meister</i>	137

3.5	Planning Methods for Manufacturing Functionally Graded Components - Challenges and Solutions.....	145
	<i>Dirk Biermann, Jürgen Gausemeier, Stefan Hess, Marcus Petersen and Tobias Wagner</i>	
4	Component Properties	155
4.1	Crack Initiation and Crack Growth.....	157
	<i>Angelika Brückner-Foit, Hans Albert Richard, Maria Specovius-Neugebauer, Britta Schramm, Martin Steigemann, Tobias Stein and Frank Zeismann</i>	
4.2	Residual Stresses.....	169
	<i>Berthold Scholtes and Wolfgang Zinn</i>	
	Authors Index.....	175