
Advances on Hot Extrusion and Simulation of Light Alloys

Edited by
A. Erman Tekkaya and Nooman Ben Khalifa


**Advances on
Hot Extrusion
and Simulation
of Light Alloys**

Advances on Hot Extrusion and Simulation of Light Alloys

Selected, peer reviewed papers from the International Conference
on Extrusion and Benchmark (ICEB),
Dortmund 2009, Germany, September 16. -17. 2009

Edited by

A. Erman Tekkaya and Nooman Ben Khalifa

 **TRANS TECH PUBLICATIONS LTD**
Switzerland • UK • USA

Copyright © 2010 Trans Tech Publications Ltd, Switzerland

All rights reserved. No part of the contents of this publication may be reproduced or transmitted in any form or by any means without the written permission of the publisher.

Trans Tech Publications Ltd
Laubisrutistr. 24
CH-8712 Stafa-Zurich
Switzerland
<http://www.ttp.net>

Volume 424 of
Key Engineering Materials
ISSN 1013-9826
Full text available online at <http://www.scientific.net>

Distributed worldwide by
Trans Tech Publications Ltd.
Inc.
Laubisrutistr. 24
CH-8712 Stafa-Zurich
Switzerland

Fax: +41 (44) 922 10 33
e-mail: sales@ttp.net

and in the Americas by
Trans Tech Publications
PO Box 699, May Street
Enfield, NH 03748
USA

Phone: +1 (603) 632-7377
Fax: +1 (603) 632-5611
e-mail: sales-usa@ttp.net

Printed in the Netherlands

Preface

This special issue of the journal “Key Engineering Materials” contains peer reviewed papers presented at the International Conference on Extrusion and Benchmark (ICEB). They give an insight into the latest advances in extrusion technology and its simulation. The papers cover a wide range of topics and are grouped into the categories of: benchmark, microstructure, seam welds & composite extrusion, material flow & constitutive equations, dies & tools, and process control & optimization. However, many more topics such as new materials (magnesium and composites) and new profiles (composite profiles), have been covered.

In particular the benchmark part at the conference aimed at exploiting FEM code capabilities and users’ knowledge in the simulation of an industrial extrusion process as it was experimentally realized by the conference organizers. In the 2009 edition of the benchmark, a two-hole die has been used for producing two U-shape profiles with different supporting legs. The experiments have been strictly monitored. The influence of die deformation on the extrusion speed, temperature distribution and distortion of the two profiles is reported and analyzed. Due to the complexity of this matter, the benchmark should not be considered as a contest: Instead, it should be recognized as an opportunity to detect, explore and discuss various issues about common simulation practice, with each participant having his/her own particular interest. We hope that these results will serve for the improvement of the existing simulation skills and also help to develop the future benchmark experiments.

Finally, we would like to express our gratitude to the reviewers of the submitted papers, principally to our co-organizers Professor Luca Tomesani and Dr. Lorenzo Donati of University of Bologna, for their hard work and critical but constructive remarks, which helped the conference to maintain a high scientific level. We hope that the proceedings will become a source of valuable information useful in scientific work for researchers, engineers and students and we were pleased to welcome everyone to Dortmund to the international Extrusion Conference and Benchmark.

Prof. Dr. -Ing. A. Erman Tekkaya
Conference chairman

Nooman Ben Khalifa
Conference organizer

Committees

Conference Chair

Prof. A. Erman Tekkaya, IUL Dortmund University of Technology, DE

Scientific Committee

Dr. C. Bruni, DIPMEC, Marche Polytechnic University, IT

Prof. S. Bruschi, DIMS, University of Trento, IT

Dr. L. Donati, DIEM, University of Bologna, IT

Prof. I. Duplancic, University of Split, HR

Dr. M. El Mehtedi, DIPMEC, Marche Polytechnic University, IT

Prof. J. Hirsch, Hydro, DE

Prof. P. Hora, IVP, ETH Zurich, CH

Prof. J. Hueting, DET, University of Twente, NL

Dr. A.J. Koopman, DET, University of Twente, NL

Prof. H. J. McQueen, Concordia University, CA

Prof. F. Micari, DTMPIG, University of Palermo, IT

Prof. W. Misiolek, Lehigh University, US

Dr. S. Müller, ERC, TU Berlin, DE

Prof. Neitzert, School of Engineering, Auckland University of Technology, NZ

Dr. M. Schaper, IW, University Hannover, DE

Prof. T. Sheppard, University Bournemouth, GB

Prof. C. Sommitsch, TUG, Graz University of Technology, AT

Prof. G. Tani, DIEM University of Bologna, IT

Prof. A. E. Tekkaya, IUL, Dortmund University of Technology, DE

Prof. L. Tomesani, DIEM, University of Bologna, IT

Prof. H. Valberg, NTNU, Norwegian University, NO

Dr. X. Velay, University Bournemouth, GB

Dr. J. Zhou, LMP, Delft University, NL

Industrial Committee

W. Dalla Barba, Italteco/Interall, IT

A. Den Bakker, Nedal Aluminium B.V., NL

H. Gers, Honsel AG, DE

V. Giacomelli, Compes S.p.A., IT

Dr. A. Klaus, LeanSigma, DE

J. Maier, WEFA Inotec GmbH, DE

G. Olcelli, Olex Technologies, CA

G. T. Rajsky, Extrusion Technology for Aluminum Profiles Foundation, USA

M. Rompato, Pandolfo Alluminio, IT

R. Rusticelli, Phoenix International, IT

Dr. A. Bacha, Alcan Extruded Products, Sierre, CH

Table of Contents

Preface

Committees

I. Keynotes

Combined Numerical Simulation and Microstructure Characterization for Prediction of Physical Properties in Extruded Aluminum Alloys W.Z. Misiolek and W.R. Van Geertruyden	1
Towards Predictive Control of Extrusion Weld Seams: An Integrated Approach A.J. den Bakker, R.J. Werkhoven, W.H. Sillekens and L. Katgerman	9

II. Extrusion Benchmark

Extrusion Benchmark 2009 Experimental Analysis of Deflection in Extrusion Dies D. Pietzka, N. Ben Khalifa, L. Donati, L. Tomesani and A.E. Tekkaya	19
--	----

III. Microstructure and Heat Treatment

Physically Based Microstructure Modelling of AA6082 during Hot Extrusion F. Krumpal, P. Sherstnev, S. Mitsche, S. Randjelovic and C. Sommitsch	27
An Assessment of the Grain Structure Evolution during Hot Forward Extrusion of Aluminum Alloy 7020 A. Foydl, N. Ben Khalifa, A. Brosius and A.E. Tekkaya	35
Modeling and Simulation of Microstructure Evolution in Extruded Aluminum Profiles F. Parvizian, T. Kayser and B. Svendsen	43
Simulation of the Quench Sensitivity of the Aluminum Alloy 6082 A. Güzel, A. Jäger, N. Ben Khalifa and A.E. Tekkaya	51
Simulation of Gas and Spray Quenching during Extrusion of Aluminium Alloys M. Reich, S. Schöne, O. Kessler, M. Nowak, O. Grydin, F. Nürnberger and M. Schaper	57
An Approach to Simulate Shape Distortion due to Cooling in Aluminum Extrusion S. Bikass, B. Andersson and X. Ma	65
Analysis of Polypropylene Deformation in a 135° ECAE Die: Experiments and Three-Dimensional Finite Element Simulations B. Aour, F. Zaïri, M. Naït-Abdelaziz, J.M. Gloaguen and J.M. Lefebvre	71

IV. Seam Welds and Composite Extrusion

Analysis of Joint Quality along Welding Plane E. Ceretti, L. Filice, L. Fratini, F. Gagliardi, C. Giardini and D. La Spisa	79
Accurate Welding Line Prediction in Extrusion Processes T. Kloppenborg, N. Ben Khalifa and A.E. Tekkaya	87
Simulation of Porthole Die Extrusion Process Comparing NEM and FEM Modelling I. Alfaro, F. Gagliardi, E. Cueto, L. Filice and F. Chinesta	97
Numerical Analysis of Aluminum Alloys Extrusion through Porthole Dies J. Zasadziński, A. Rekas, W. Libura, J. Richert and D. Leśniak	105
Simulation of the Co-Extrusion of Hybrid Mg/Al Profiles J. Muehlhause, S. Gall and S. Mueller	113
Effect of Tube Wall Thickness in Joining of Aluminum Tube and Holed Rib by Extrusion T. Moroi, T. Kuboki and M. Murata	121
Numerical and Experimental Investigations of the Production Processes of Coextruded Al/Mg-Compounds and the Strength of the Interface K. Kittner and B. Awiszus	129
The Use of Extruded Profiles as Filling Material in Friction Stir Welding (FSW) L. Donati and L. Tomesani	137