

# **International Deep-Drawing Research Group (IDDRG 2020)**

IOP Conference Series: Materials Science and Engineering  
Volume 967

Seoul, South Korea  
26 - 30 October 2020

## **Editors:**

**Myoung-Gyu Lee**  
**Daeyong Kim**

**Jung Han Song**  
**Ji Hoon Kim**

ISBN: 978-1-7138-4788-5  
ISSN: 1757-8981

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

This work is licensed under a Creative Commons Attribution 3.0 International Licence.  
Licence details: <http://creativecommons.org/licenses/by/3.0/>.

No changes have been made to the content of these proceedings. There may be changes to pagination and minor adjustments for aesthetics.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact the Institute of Physics  
at the address below.

Institute of Physics  
Dirac House, Temple Back  
Bristol BS1 6BE UK

Phone: 44 1 17 929 7481  
Fax: 44 1 17 920 0979

[techtracking@iop.org](mailto:techtracking@iop.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

39th International Deep Drawing Research Group Conference

Peer review declaration

Semi – automatic approach for the creation of non - proportional load paths .....	1
<i>R. Norz, W. Volk</i>	
Finite Element Study on Pattern of Pins Supporting an Elastic Blankholder Used for Stamping Irregular Shaped Sheet Metal Parts .....	8
<i>K J Fann, M Liewald</i>	
Improved coining force calculations through incorporation of key process parameters .....	17
<i>D Cotton, A Maillard, J Kaufmann</i>	
The study on the relationship between the friction characteristic and the formability of the automotive steel sheet during the stamping process .....	25
<i>J Y Kim, S C Yoon, J S Hyun, M.-G. Lee</i>	
Investigation on water as lubricant in combination with a structured tool surface in micro metal forming .....	30
<i>L Rathmann, T Czotscher, T Radel, F Vollertsen</i>	
Influence of anisotropy evolution on strain path independent failure limits .....	36
<i>K Bandyopadhyay, S Basak, M G Lee</i>	
A novel experimental set-up for in-situ microstructural characterization during continuous strain path change .....	43
<i>S Dhara, S Taylor, L Figiel, B Shollock, S Hazra</i>	
Influence of a drawbead passage in deep drawing processes on surface values and the tribological system .....	56
<i>Harald Schmid, Marion Merklein</i>	
Determination of the properties of semi-finished parts in blanking processes .....	66
<i>S Wiesenmayer, P Frey, M Lechner, M Merklein</i>	
The effect of friction and lubrication modelling in stamping simulations of the Ford Transit hood inner panel: a numerical and experimental study .....	74
<i>S Berahmani, C Bilgili, G Erol, J Hol, B Carleer</i>	
Experimental Investigation of Multi-stage Deep Drawing of IN718 Sheet at Elevated Temperature.....	81
<i>Kanhu C Nayak, Prashant P Date</i>	
Comparative Investigation on Aluminum Material Modeling with applications to Springback Prediction .....	89
<i>Z Deng</i>	
Crystal Plasticity Simulation of the AZ31B Alloy Sheet under Uniaxial Deformation Considering Grain Boundary Sliding .....	97
<i>Zihan Li, Dayong Li, Weiqin Tang, Huamiao Wang, Yinghong Peng</i>	
Reverse-loading coefficients identification for updated homogeneous anisotropic hardening model.....	103
<i>Shin-Yeong Lee, Jin-Hwan Kim, Frédéric Barlat</i>	

Soft sensing force measurement approach in sheet metal forming facilities .....	109
<i>Jon Olaizola, Aitzol Iturrospe, Jose Manuel Abete, Lander Galdos, Eneko Sáenz de Argandoña</i>	
Prediction of Mechanical Behaviors of the Q & P980 Steel Under Different Temperatures and Strain Rates Using Crystal Plasticity Method .....	117
<i>Hao Yang, Huamiao Wang, Dayong Li, Yinghong Peng, Peidong Wu</i>	
Mechanical properties and formability of EN AW-7075 in cold forming processes.....	124
<i>B-A Behrens, S Hübner, H Vogt, O Golovko, S Behrens, F Nürnberger</i>	
Effects of Lubrication and Temperature on the Tribological Behavior of a Magnesium Alloy under Contact Sliding .....	132
<i>C H Wu, L C Zhang, P L Qu, S Q Li, Z L Jiang, Y Wang</i>	
Nondestructive detection of the interfacial failure of steel-polymer sandwich composites during forming process .....	140
<i>Jewook Yang, Sungjin Han, Woong-Ryul Yu</i>	
Formability simulation of steel-polymer sandwiched composites considering the adhesion strength .....	146
<i>S Han, J Yang, W-R Yu</i>	
The Investigation of Zinc Coating Quality with Different Thickness Levels After Forming of Flat Steels .....	153
<i>E Tamer, O Yildirim</i>	
Fuzzy modelling of surface scratching in contact sliding.....	160
<i>Wei Li, Liangchi Zhang, Xinping Chen, Chuhan Wu, Zhenxiang Cui, Chao Niu</i>	
Development of Sheet Metal Forming Analysis Incorporating Phase-transformation Model for Hot Stamping.....	168
<i>K Uenishi, M Kubo, T Suzuki, K Okamura</i>	
Numerical analysis of the bulge test in temperature for the EN AW 6061-T6 sheet.....	177
<i>A Boyer, L Germain, H Laurent, D M Neto, M C Oliveira</i>	
Identification of methods for the in-situ measurement of cutting forces in a tool-bound punching machine .....	185
<i>S Niessner, M Liewald</i>	
A Method to Incorporate Grain Boundary Strength and its Effects on Plastic Deformation in FCC Polycrystals .....	194
<i>W Muhammad, A P Brahme, J Kang, E Cyr, D S Wilkinson, K Inal</i>	
The roles of yield function and plastic potential under non-associated flow rule for formability prediction with perturbation approach.....	207
<i>Q Hu, J W Yoon</i>	
Description of stress-strain response and evaluation of the formability for Al-Cu-Mg alloy under the impact hydroforming .....	214
<i>Da-Yong Chen, Shi-Hong Zhang, Yong Xu, Yan Ma, Hong-Wu Song, Liang-Liang Xia</i>	
A pressure-coupled Drucker function for plasticity and fracture modelling of AA5182 .....	222
<i>Chong Zhang, Yue Wang, Yanshan Lou, Lei Fu, Saijun Zhang, Jeong Whan Yoon</i>	

Strain hardening under large deformation for AA5182.....	229
<i>Chong Zhang, Yue Wang, Hongchun Shang, Pengfei Wu, Lei Fu, Yanshan Lou, Till Clausmeyer, A. Erman Tekkaya, Qi Zhang</i>	
Comparison of Artificial Intelligence Methods for Prediction of Mechanical Properties .....	235
<i>Kyungmin Lee, Charmgil Hong, Eun-Ho Lee, WooHo Yang</i>	
A novel uncoupled ductile fracture criterion for prediction of failure in sheet metal forming.....	243
<i>H Quach, J J Kim, J H Sung, Y S Kim</i>	
An Infrared local heat-treatment method to improve local formability of forming and trimming processes.....	250
<i>Ki-Young Kim, Soohyun Park, Eun-Ho Lee, Youn Hee Kang</i>	
Additive Manufacturing of Tailored Blank for Sheet-Bulk Metal Forming Processes .....	256
<i>R Schulte, T Papke, M Lechner, M Merklein</i>	
Development of inline closed-loop vibration control in progressive die stamping using finite element simulation .....	265
<i>F Steinlehner, M Ott, D Budnick, A Weinschenk, S Laumann, M Worswick, W Volk</i>	
Evolution of a forming limit curve for non-linear strain paths induced on advanced high-strength sheet steel with its proven applicability to a complex deep-drawing process.....	273
<i>K Chongbunwatana, S Panich, K Laokor</i>	
Influence of anisotropic yield criteria on simulation accuracy of the hole-expansion test .....	281
<i>S Panich, K Chongbunwatana</i>	
Axial formation and cross-section distortion control for stretch bending based on batch simulations.....	289
<i>Kaijun Lu, Jianxi Luo, Tianxia Zou, Dayong Li, Yinghong Peng</i>	
The formability and application of hot-rolled dual-phase steel under nonlinear strain paths.....	302
<i>W J Chen, H W Song, X H Pei, S H Zhang</i>	
Forming and trimming of 2-mm thick DP600 sheet steel in tools and dies 3D-printed in maraging steel by laser-based powder bed fusion .....	308
<i>Thomas Skåre, Nader Asnafi</i>	
New Physical Scaling Approach to compensate the part contraction in drawing operations .....	316
<i>A Birkert, P Zimmermann, B Hartmann, M Scholle, M Straub</i>	
Measurement-based evaluation of interfacial polymer layer inserted in sound deadening laminated sheet.....	324
<i>Hyeonil Park, Se-Jong Kim, Jinwoo Lee, Daeyong Kim</i>	
Enhancement of Edge Crack Predictability for Automotive High-Strength Thick Steel Sheets Considering the Pressure Effect .....	328
<i>Gihyun Bae, Namsu Park, Junghan Song, Jongsup Lee, Inje Jang, Keunyoung Park</i>	
The mechanical properties of high strength Al alloy sheet under quasi-static-dynamic loading.....	335
<i>L L Xia, Y Xu, S H Zhang, H W Song, D Y Chen</i>	
Numerical modelling and formability of with and without heat-treated AA 6023-T6 alloy sheet with various necking/failure criteria.....	340
<i>Perumalla Janaki Ramulu, Habtamu Beri, P. Srinivasa Rao, Devender Kumar Sinha, Moera Gutu</i>	

Inelastic strain recovery of magnesium alloys and a new elastic modulus model.....	348
<i>YU Hai Yan, WU Hangyu, Wang Lin</i>	
Investigation on ductile fracture of an aluminium alloy using a mean-field crystal plasticity framework .....	361
<i>J Lee, H Park, M Joo, Y Jeong</i>	
Springback and end flare compensation in flexible roll forming.....	371
<i>B Abeyrathna, S Ghanei, B Rolfe, R Taube, M Weiss</i>	
Finite element analysis of self-piercing riveting of aluminum alloy and carbon fiber reinforced polymer composites.....	378
<i>Y C Hur, D Kim, K S Lee, M G Bae, S E Park, J H Kim</i>	
Evaluation of the stress-strain relationship in the high strain region of high strength materials by using the shear stretch test.....	382
<i>Y Taguchi, Y Maeda, Y Maeda</i>	
A fully coupled damage model with stress triaxiality and Lode dependence.....	391
<i>K Zhang, H Badreddine, N Hfaiedh, K Saanouni, J Liu</i>	
Distortional Hardening Behavior and Strength Different Effect of Pure Titanium Grade 1 Sheets: Experimental Observation and Constitutive Modeling.....	397
<i>Quoc Tuan Pham, Myoung Gyu Lee, Young Suk Kim</i>	
Dynamic hardening properties identification utilizing acceleration data by the Virtual Fields Method .....	402
<i>Ji-Min Kim, Jin-Hwan Kim, Frédéric Barlat</i>	
Study of Khan-Huang-Liang (KHL) Anisotropic Deformation Model for Deep Drawing Behaviour of Inconel 718 Alloy.....	408
<i>Gauri Mahalle, Omkar Salunke, Nitin Kotkunde, Amit Kumar Gupta, Swadesh Kumar Singh</i>	
Deformation characteristics in 3D free-bending forming of complex spiral tubes.....	416
<i>A Abd El-Aty, W Wei, X Guo, H Wang, J Tao, H Chen, Y Qin</i>	
The determination of friction coefficient in Nakazima test and its application in predicting FLCs with modified M-K model.....	424
<i>Yubao Wang, Cunsheng Zhang</i>	
Material testing of magnesium alloy AZ31B using a finite element polycrystal method based on a rate independent crystal plasticity model .....	430
<i>Giorgio Vago, Tetsuo Oya</i>	
A simple device to measure bend limit of sheet metals.....	437
<i>A Deole, N Etxebarria, J Mendiguren, A Ilinich, M Weiss</i>	
Effect of cooling system in hot stamping process .....	445
<i>P Srimon Narayanasamy, Amarjeet Kumar Singh, K Narasimhan</i>	
Identification of the anisotropic plasticity using the virtual fields method for 2024 aluminium alloy .....	452
<i>J W Fu, W W Xie, Z Ma, L H Qi</i>	
Evaluation of Sliding Wear Behaviour for STD11 Coated with TiCN Using the Pin-on-Disk Test.....	458
<i>J H Bang, J H Song, G H Bae, N S Park, S O Choi, M G Lee, H G Kim</i>	

Work-hardening behavior prediction model of arbitrary reloading process based on material crystallographic structure .....	464
<i>T Oya, J Yanagimoto, K Ito, G Uemura, N Mori</i>	
A novel testing method to evaluate edge formability nondestructively with eddy current.....	470
<i>J Gu, N Pathak, S Freed, E Todorov, H Kim</i>	
A Study on Effects of the Press Speed on Sheared Edge Formability .....	478
<i>J Gu, F Alamos, D Schoch, J Bornhorst, H Kim</i>	
Development of springback tester and the effect of forming speed on the springback of four sheet metal bending processes .....	486
<i>Dou Luyi, Li Xiaoqiang, Dong Hongrui, LI Dongsheng, Peng Xingyi</i>	
A new workflow for the effective distinction between necking induced spilts and direct fracture phenomena.....	493
<i>N Manopulo, B Carleer</i>	
Crystal plasticity as complementary modelling technique for improved simulations results of anisotropic sheet metal behaviour in forming processes .....	500
<i>Sebastian Hirsiger, Bekim Berisha, Holger Hippke, Pavel Hora</i>	
Potentials of an adaptive blank positioning to control material and process fluctuations in deep drawing.....	508
<i>David Briesenick, Mathias Liewald, Patrick Cyron</i>	
Prediction of limit strains during non-proportional load paths with a change in loading direction.....	515
<i>W. Volk, M. Gruber, R. Norz</i>	
Development of rapid heat solid solution process of Al 7075-T6 alloy applying near-infrared ray heater .....	523
<i>Seon-Ho Jung, Yongbae Kim, Seogou Choi, Jongsup Lee</i>	
Reduced texture approach for crystal plasticity finite element method toward macroscopic engineering applications .....	529
<i>D Noh, J W Yoon</i>	
Lubricant Selection and Post Forming Material Characterization in Incremental Sheet Forming .....	535
<i>Amrut Mulay, Satish Ben, Syed Ismail</i>	
Simulation of springback in cyclic wipe-bending .....	543
<i>H H Bok, K S Oh, Y S Kang</i>	
Compensation of elastic die and press deformations during sheet metal forming by optimizing blank holder design .....	552
<i>M Burkart, P Essig, M Liewald, M Beck, M Mueller</i>	
Inferring the surface roughness of Al-Si coated 22MnB5 steel using an in situ laser speckle characterization technique .....	562
<i>C M Klassen, J Emmert, K J Daun</i>	
Evaluation of 22MnB5 Steel Austenitization Sub-Models for Simulating the Heating Phase of Hot Stamping.....	575
<i>B Zhao, C Chiriac, K J Daun</i>	

A simplified method for the evaluation of the layer compression test using one 3D digital image correlation system and considering the material anisotropy by the equibiaxial Lankford parameter.....	585
<i>A A Camberg, T Tröster</i>	
On the design of an air-cooling system of an IC engine block made from sheet metal.....	593
<i>Prashant P Date, Shubham P Dhonde</i>	
Experimental issues in the instrumented 3 point bending VDA238-100 test .....	601
<i>L. Wagner, P. Larour, D. Dolzer, F. Leomann, C. Suppan</i>	
Edge crack sensitivity versus tensile local ductility of AHSS sheet steels .....	612
<i>P Larour, J Freudenthaler, M Kerschbaum, D Dolzer</i>	
A new technique for characterising mechanical properties of materials under hot stamping conditions .....	621
<i>R Zhang, J Lin, Z Shi, Z Shao</i>	
Interaction between forming and joint quality of the friction-assisted clinching .....	629
<i>Zhiyong Li, Zhiyong Wang, Yong Li, Shanling Han</i>	
Numerical and Experimental Investigation on Hot Stamping of TWB B-Pillar .....	636
<i>Cheng-Kai ChiuHuang, Ming-Feng Chiang, Ping-Kun Lee</i>	
A full-field optimization approach for iterative definition of yielding for non-quadratic and free shape yield models in plane strain.....	645
<i>Holger Hippke, Bekim Berisha, Pavel Hora</i>	
Study on the influence of the yield surface shape in the hole expansion test .....	656
<i>M C Oliveira, D M Neto, J L Alves, LF Menezes</i>	
Heat generation when forming AHSS: experimental and numerical analysis of tensile and draw-bead tests .....	664
<i>D M Neto, J R Barros, M C Oliveira, P V Antunes, A Ramalho, R L Amaral, A D Santos, J L Alves, L F Menezes</i>	
Forming limit of sheet metal in cylindrical deep drawing with a conical die.....	672
<i>Luo Xin, C A Evsyukov, Yu Zhongqi</i>	
New tool to evaluate the fracture resistance of thin high strength metal sheets .....	678
<i>D Frómeta, A Lara, S Parareda, L. Grifé, D Casellas</i>	
Experimental Analysis of Warping Defects in Chain-die Forming Variable-width Profiles.....	689
<i>Zhenye Liang, Tianxia Zou, Dayong Li, Hua Xiao, Lei Shi, Shichao Ding, Yinghong Peng</i>	
Deep drawing behavior of IN625 alloy under the influence of different process parameters .....	695
<i>Ayush Morchhale, Nitin Kotkunde, Swadesh Kumar Singh</i>	
Study on the Anti-friction properties of Chemically Etched surface texture and its synergistic Anti-friction properties with nano-lubricating oil in sheet metal deep drawing process .....	703
<i>Tangjie Mei, Dongliang Zhang, Qi Zhang</i>	

**Author Index**