



# FORMING THE FUTURE

Proceedings of the  
13<sup>th</sup> International Conference  
on the Technology of Plasticity

**EDITED BY**

Glenn Daehn · Jian Cao · Brad Kinsey  
Erman Tekkaya · Anupam Vivek  
Yoshinori Yoshida



TMS

 Springer

# **The Minerals, Metals & Materials Series**

Glenn Daehn · Jian Cao · Brad Kinsey ·  
Erman Tekkaya · Anupam Vivek ·  
Yoshinori Yoshida  
Editors

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# Preface

Dear Colleague,

The “lucky” thirteenth International Conference on the Technology of Plasticity (ICTP) was the meeting that just was not destined to happen live. The COVID-19 pandemic forced us to move it from July 2020 to July 2021, and now as I write, the world is starting to recover, vaccinations are coming, but the end of July 2021 is just too early for extensive international travel. This represents the archive of peer-reviewed papers that accompany this meeting.

This is a meeting series with the strongest of international traditions. Meetings have been held in Tokyo, Japan (1984); Stuttgart, Germany (1987); Kyoto, Japan (1990); Beijing, China (1993); Columbus, Ohio, USA (1996); Nuremberg, Germany (1999); Yokohama, Japan (2002); Verona, Italy (2005); Gyeongju, Korea (2008); Aachen, Germany (2011); Nagoya, Japan (2014); and Cambridge, England, and this meeting was to be held in Columbus, Ohio, USA.

This meeting has a strong tradition, and we hope that the papers here and the remote meeting format will maintain the ICTP’s traditions of innovation impact and collegiality across the globe.

This meeting is noteworthy also for several special symposia for pioneers of metal forming:

Taylan Altan, The Ohio State University, USA

Niels Bay, Technical University of Denmark, Denmark

Xue-yu Ruan, Shanghai Jiao Tong University, China (memorial symposium)

Yasuhisa Tozawa, Nagoya University, Japan

Rob Wagoner, The Ohio State University, USA

Zhongren Wang, Harbin Institute of Technology, China

I am grateful for the many hours of planning (much for events that are not to be realized) by the planning committee:

Glenn Daehn, The Ohio State University, USA

Jian Cao, Northwestern University, USA

Brad Kinsey, University of New Hampshire, USA

Erman Tekkaya, Technical University of Dortmund, Germany

Anupam Vivek, The Ohio State University, USA  
 Yoshinori Yoshida, Gifu University, Japan

Despite the unusual circumstances, I think you will agree that this series of full papers (246) shows great quality and innovation in keeping with the spirit of ICTP. The papers are arranged topically and then alphabetically.

The organizers wish to thank the various people and institutions that supported us in organizing the ICTP and in preparing the proceedings. Our sincere thanks go to all authors who submitted excellent papers and who make our (metal) forming community so strong. Secondly, we wish to thank all our reviewers who carefully and constructively evaluated all the submitted papers. The bulk of this reviewing was carried out by the international scientific committee, which is named below and the members of my research group who skillfully filled in several gaps. We are also grateful to the members of the scientific committee and the standing advisory board for their valuable help and advice.

I hope you find these innovative papers useful and enjoy the online conference.  
 With best wishes,



Glenn Daehn  
 Mars G. Fontana Professor of Metallurgical Engineering  
 The Ohio State University  
 Columbus, OH, USA

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