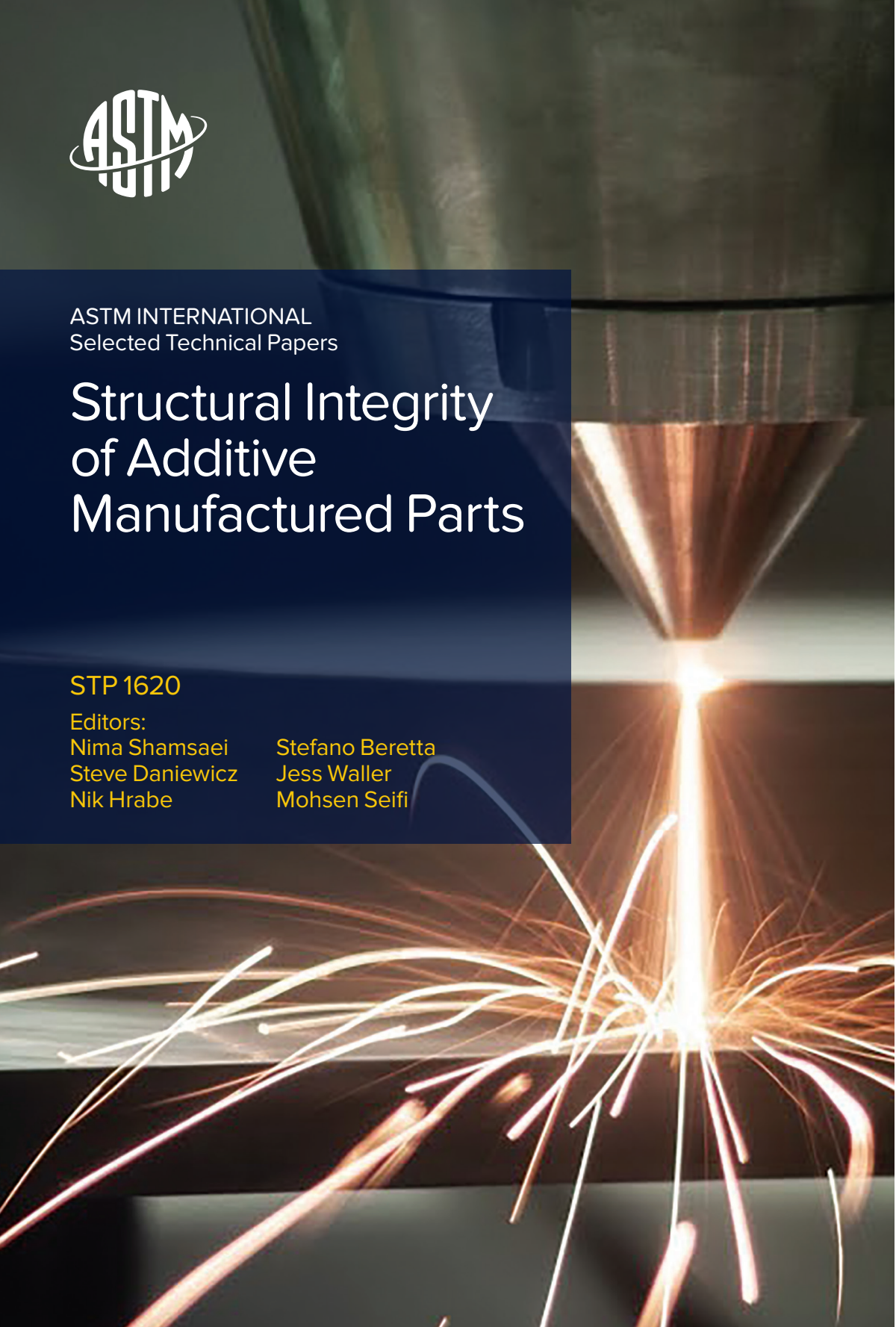

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Selected Technical Papers

Structural Integrity of Additive Manufactured Parts

STP 1620

Editors:
Nima Shamsaei
Steve Daniewicz
Nik Hrabe
Stefano Beretta
Jess Waller
Mohsen Seifi

SELECTED TECHNICAL PAPERS
STP1620

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Foreword

THIS COMPILATION OF Selected Technical Papers, STP1620, *Structural Integrity of Additive Manufactured Parts*, contains peer-reviewed papers that were presented at a symposium held November 6–8, 2018, in Washington, DC, USA. The symposium was sponsored by ASTM International Committee F42 on Additive Manufacturing Technologies, with co-sponsorship from Committees E08 on Fatigue and Fracture and E07 on Nondestructive Testing.

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Overview

To ensure the structural integrity of additively manufactured (AM) parts, it is critical to establish feedstock-process-structure-property-performance relationships, particularly where these components and structures are being used in safety-critical applications. ASTM International (ASTM), in coordination with partners from government, industry, and academia, has organized a series of annual symposia to help address these needs.

The 3rd ASTM Symposium on Structural Integrity of Additive Manufactured Parts—which took place from November 6–8, 2018, in Washington, DC—was designed to provide a forum for the exchange of ideas regarding the structural integrity of parts fabricated using AM, with a focus on the lack of industry standards and design principles, as well as qualification and certification challenges.

The event was co-sponsored by ASTM Committee F42 on Additive Manufacturing Technologies, along with Committees E08 on Fatigue and Fracture and E07 on Nondestructive Testing. It was supported by the ASTM Additive Manufacturing Center of Excellence (AM CoE), National Aeronautics and Space Administration (NASA), National Institute of Standards and Technology (NIST), European Structural Integrity Society (ESIS) TC15, and the U.S. National Congress for Theoretical and Applied Mechanics.

Approximately 250 people attended the 3-day event, representing 11 different nations around the world. The symposium included 56 talks by experts from industry, government, and academia, and 3 panel discussions, which covered nondestructive testing and the challenges of AM standardization and adoption in the medical device and aerospace industries.

The 27 selected technical papers in this collection provide an opportunity to delve more deeply into the wide variety of topics covered during the symposium. While individual papers often touch on multiple topics, the following list presents the major areas covered in the symposium and the papers that address each topic as their primary focus.

A significant emphasis of this symposium was on nondestructive evaluation and in situ monitoring of AM parts, and the below articles are in this category:

- *Metal Additive Manufacturing Defect Formation and Nondestructive Evaluation (NDE) Detectability*
- *Evaluation of Nondestructive Volumetric Testing Methods for Additively Manufactured Parts*

- *NDE-Based Quality Assurance of Metal Additively Manufactured Aerospace Parts at NASA, JAXA, and ESA*
- *Eddy Current Technologies for Real-time Monitoring and Post Process Examination of Laser Powder Bed Fusion Process*
- *Nondestructive Evaluation of Additive Manufactured Parts Using Process Compensated Resonance Testing*
- *Nondestructive Evaluation of Programmed Defects in Ti-6Al-4V L-PBF ASTM E8-Compliant Dog-Bone Samples*

As the lack of understanding and standardization to capture the structural integrity of AM parts is still a major roadblock against the adoption of AM in load-bearing, safety critical applications, many papers presented relating to fatigue, fracture, tensile, and corrosion behavior of materials and parts fabricated using AM were presented. Effects of design, process, and post-process parameters on fatigue and fracture properties as well as process optimization to improve structural integrity of AM parts were also discussed extensively. Applicability of existing mechanical test methods to AM parts and innovative approaches to standardization were emphasized in this symposium. The following papers focus on related topics for this category:

- *Expression of Additive Manufacturing Surface Irregularities through a Flaw-Based Assessment*
- *Development and Testing of 316L Stainless Steel Metal Additive Manufacturing Test Articles for Powder Bed Fusion and Directed Energy Deposition Processes*
- *Effects of the Shielding Argon Gas Flow on the Mechanical and Physical Properties of Selective Laser Melted Ti-6Al-4V Solid Material*
- *Influence of Intentionally Induced Porosity and Postprocessing Conditions on the Mechanical Properties of Laser Powder Bed-Fused Inconel 625*
- *Elucidating the Impact of Processing Parameters of Additive Manufactured Materials Using Microscale Tensile Samples*
- *Additive Manufactured Polymer Test Coupons—Issues and Solutions*
- *Coupon-Level Mechanical Testing for Polymer Based Additive Manufacturing*
- *Characterization of Stress Fields Near Pores and Application to Fatigue Lives*
- *Fatigue and Fracture Behavior of Additively Manufactured Austenitic Stainless Steel*
- *Fatigue Behavior of Laser Metal Deposited 17-4 PH Stainless Steel*
- *Fatigue Assessment of 17-4 PH Stainless Steel Notched Specimens Made by Direct Metal Laser Sintering*
- *A Comparison of Stress Corrosion Cracking Susceptibility in Additively-Manufactured Ti-6Al-4V for Biomedical Applications*
- *Fatigue Properties of Additive Manufactured Ti-6Al-4V and CoCr-Alloy Total Ankle Components*

- *Primary Processing Parameter Effects on Defects and Fatigue in Alloy 718*
- *Role of Post-Fabrication Heat Treatment on the Low-Cycle Fatigue Behavior of Electron Beam Melted Inconel 718 Superalloy*
- *An Efficient Test Method for the Quantification of Technology-Dependent Factors Affecting the Fatigue Behavior of Metallic AM Components*
- *Probabilistic Computational Fatigue and Fracture Modeling of Additive Manufactured Components*
- *Probabilistic Framework for Defect Tolerant Fatigue Assessment of AM Parts Applied to a Space Component*

Finally, recent advances in standardization, qualification and certification were presented:

- *Rapid Additive Qualification Using Probabilistics (RAQUP)*
- *Performance Signature Qualification for Additively Manufactured Parts under Conditions Emulating In-Service Loading*
- *NASA's Efforts for the Development of Standards for Additive Manufactured Components*

We would like to extend our gratitude to everyone who made this symposium possible. The hard work of the authors, coauthors, our symposium co-chairs and co-editors, peer reviewers, and personnel of ASTM and its AM CoE partners, as well as the support of NASA, NIST, ESIS TC15, and the U.S. National Congress for Theoretical and Applied Mechanics all played a major role in the success of the symposium and this publication.

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