SAE INTERNATIONAL®

SAE EDGE™ RESEARCH REPORT

Unsettled Topics on Surface Finishing of Metallic Powder Bed Fusion Parts in the Mobility Industry

Kevin T. Slattery, DSc

SAE EDGE™
RESEARCH REPORT

Unsettled Topics on Surface Finishing of Metallic Powder Bed Fusion Parts in the Mobility Industry

Kevin T. Slattery, DSc
The Barnes Global Advisors

EDGE DEVELOPMENT TEAM

Marc Farfaglia, *PostProcess Technologies*
Eliana Fu, PhD, *Relativity Space*
Wolfgang Hansal, PhD, *RENA Technologies*
John Laureto and Dan Skulan, *Renishaw*
Jon Meyer, *APWORKS*
John Middendorf, PhD, *ARCTOS*
Nick Studley, *Extrude Hone*

SAE INTERNATIONAL®

Warrendale, Pennsylvania, USA

About the Publisher

SAE International® is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive, and commercial-vehicle industries. Our core competencies are lifelong learning and voluntary consensus standards development. Visit sae.org

SAE EDGE™ Research Report Disclaimer

SAE EDGE™ Research Reports focus on topics that are dynamic, in which knowledge is incomplete, and which have yet to be standardized. They represent the collective wisdom of a group of experts and serve as a practical guide to the reader in understanding unsettled subject matter. They are not meant to provide a recommended practice or protocol. The experts have assembled as a community of practitioners to contribute and collectivize their thoughts and points of view. These are not the positions of the institutions or businesses with which they are affiliated nor one contributor's perspective advanced over others. SAE EDGE™ Research Reports are the property of SAE International, and SAE alone is responsible for their content.

About this Publication

SAE EDGE™ Research Reports provide state-of-the-art and state-of-the-industry examinations of the most significant topics in mobility engineering. Contributors to SAE EDGE™ Research Reports are experts from academia, government, industry, and research who have come together to explore and define the most critical advancements, challenges, and future direction in areas such as vehicle automation, unmanned aircraft, cybersecurity, advanced propulsion, advanced manufacturing, Internet of Things, and connectivity.

Related Resources

SAE MOBILUS® Advanced Manufacturing Knowledge Hub
https://saemobilus.sae.org/advanced-manufacturing/

SAE EDGE™ Research Report: Unsettled Topics on the Feasibility and Desirability of Using Additive Manufacturing in the Mobility Industry by Kevin T. Slattery, DSc
https://saemobilus.sae.org/content/EPR2020009/

SAE EDGE™ Research Report: Unsettled Topics on Nondestructive Testing of Additively Manufactured Parts in the Mobility Industry by Kevin T. Slattery, DSc
https://saemobilus.sae.org/content/EPR2020017/

SAE Team

Frank Menchaca, Chief Growth Officer
Michael Thompson, Director of Standards, Information, and Research Publications
Monica Nogueira, Director of Content Acquisition and Development
Beth Ellen Dibeler, Product Manager
William Kucinski, Managing Technical Editor

Printed in USA

EPR2021001
ISSN 2640-3536
e-ISSN 2640-3544
ISBN 978-1-4686-0281-4

To purchase bulk quantities, please contact: SAE Customer Service

E-mail: CustomerService@sae.org
Phone: 877-606-7323 (*inside USA and Canada*)
+1-724-776-4970 (*outside USA*)
Fax: +1-724-776-0790

https://www.sae.org/publications/edge-research-reports

About the Editor

Andy Kunkel—Triad Production Group

Kevin T. Slattery, DSc—Kevin is a Principal ADDvisor® at The Barnes Global Advisors (formerly The Barnes Group Advisors). His primary expertise is in Metallic Additive and Metals Manufacturing, focusing on test program development and process and product verification, qualification, and certification. He has supported over 25 clients on five continents throughout the entire additive manufacturing value chain—from raw material to finished components. He is a 2020 Ambassador for America Makes and was part of the Materials Challenge Silver Medal team in the United States (US) Air Force Rapid Sustainment Office Additive Manufacturing Olympics.

Kevin was previously the Chief Scientist for Additive Manufacturing at Boeing Research and Technology (BR&T). He was responsible for developing and integrating the technology roadmaps and development plans for metallics additive manufacturing for the entire company, along with building and leading a multiskilled team to execute and deliver the technology throughout the enterprise. Prior to that, he was the Chief Scientist for Metals, Ceramics, and Mechanical Systems at BR&T, with the responsibility for portfolio development and coordination, while executing the additive manufacturing portion.

He served as the division chief engineer for the US Navy and US Air Force fighter aircraft and US Army rotorcraft in Boeing's Military Sustainment organization. From 1997 to 2012, he was on the BR&T Metals Team as a researcher and senior manager, where he primarily developed advanced low-cost titanium processing technologies supporting all Boeing products. He was the technical and programmatic lead in implementing the first aerospace metal-additive manufactured structural aircraft components for both spares and production, with five other first-in-the industry technology implementations.

He began his career at McDonnell Douglas (now Boeing) as a nondestructive testing engineer, where he developed inspection technologies for metallic and composite components, along with integrating the impact of discontinuities with the acceptance criteria for carbon/epoxy composites.

Dr. Slattery holds BS and MS degrees in Metallurgical Engineering from the University of Missouri-Rolla (now Missouri S&T) and a DSc in Material Science and Engineering from Washington University in St. Louis. He currently holds 36 US patents, with another 15 applications pending, along with 36 significant publications and conference presentations.

contents

Sergey_Bogomyako/Shutterstock.com

Unsettled Topics on Surface Finishing of Metallic Powder Bed Fusion Parts in the Mobility Industry

Abstract

Laser (L-PBF) and electron-beam powder bed fusion (EB-PBF) additive manufacturing (AM) technology, or "3D printing," has transitioned from prototypes and tooling to production components of geometries that can only be made using AM in demanding fields such as medicine and aerospace. These initial applications either

- Take advantage of the relatively high surface roughness of the process
- Are in fatigue, corrosion, or flow environments where surface roughness—higher than that found in cast, machined, or sheet metal products—does not impose performance penalties

To move to the next levels of performance, the surfaces of components made by L-PBF and EB-PBF will need to be smoother than the current as-printed surfaces and will have to achieve this on increasingly more complex geometries. Finally, these surfaces will need to be produced without significantly increasing the cost of the final component.

In this third part of an ongoing series on AM, the challenges, technologies, and opportunities for surface finishing of L-PBF and EB-PBF metallic parts are discussed.

NOTE: SAE EDGE Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE Research Reports is to stimulate discussion and work in the hope of promoting and speeding the resolution of identified issues. These reports are not intended to resolve the challenges they identify or close any topic to further scrutiny.

Notes on terminology:

- **Surface Finishing** refers to the use of in-situ processing or post-processing to smooth the surface of a part made using PBF. A primary example is sanding.
- **Surface Improvement** refers to the use of in-situ processing or post-processing to impart compressive residual stresses on the surface of a part to improve fatigue properties. A primary example is shot peening.

KEVIN T. SLATTERY, DSc
The Barnes Global Advisors

EDGE Development Team

Marc Farfaglia, *PostProcess Technologies*
Eliana Fu, PhD, *Relativity Space*
Wolfgang Hansal, PhD, *RENA Technologies*
John Laureto and Dan Skulan, *Renishaw*
Jon Meyer, *APWORKS*
John Middendorf, PhD, *ARCTOS*
Nick Studley, *Extrude Hone*

ISSN 2640-3536