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## The second European Conference on the Structural Integrity of Additively Manufactured Materials

### Preface

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#### Abstract

Additive manufacturing (AM) offers the potential to economically fabricate customized parts with complex geometries in a rapid design-to-manufacture cycle. However, the basic understanding of the fracture behavior of AM materials must be substantially improved at all scale levels before the unique features of this rapidly developing technology can be used in critical load bearing applications. This ambitious target can be reached solely via adventurous interdisciplinary research. The virtual event ESIAM21, held from the 5<sup>th</sup> to the 8<sup>th</sup> of September 2021, constituted the second conference in the ESIAM series, where we continued to gather the strengths of materials science, technological processes, structural integrity assessment methodologies, and advanced design practices to innovate the area of AM materials. The conference featured 16 topics, where fatigue of AM metals, AM in aerospace and lightweight design, characterization of ceramic, polymeric and metallic materials as well as fracture of AM polymers and metals received the highest number of submissions. The conference had 105 participants distributed over 20 countries. Italy, Austria, and Belgium were the most represented countries. The present special issue comprises 38 papers centered around Fracture and Fatigue of AM metals and polymers as well as on simulation and design.

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## 1. Introduction

Innovative product design is believed to constitute the future revenue in the field of Additive Manufacturing (AM), where the ability to produce complex shaped parts facilitates light-weighting and other performance driven design opportunities. The phenomena leading to the failure of AM materials are extremely complex, not only driven by the intricate geometry but also by inherent process-property relationships. The inherent nature of the AM technology and the strong link between the evolving topology and the evolving mechanical properties is both an opportunity and a dilemma. On the one hand, this unique feature makes it possible to tune a variety of properties beyond just the macroscopic appearance. On the other hand, it leads to unprecedented complexity in manufacturing and resulting properties are difficult to be addressed in standards and recommendations that allow compliant design. Accordingly, the material and key mechanical properties of the fabricated parts are not necessarily generalizable, as they are strongly entangled with the size and geometry of the part, in addition to the specific technology employed.

This limits both the theoretical understanding and structural applications and calls for thorough guidelines that are utilizable for practitioners, not necessarily involved in the particularities of the AM processes. To promote the utilization of this technology and to infuse product innovation in sectors such as automotive, biomedicine and aerospace, to facilitate shorter lead times and safer products at lower costs, the European Conference on the Structural Integrity of Additively Manufactured Materials, in short, ESIAM, was founded in 2017 and first held in Trondheim, Norway 2019.

Since then, many advances have been made to a large extent by the ESIAM community, allowing us to be better at utilizing the enormous potential of the AM technology for end user applications. ESIAM21 constituted the second conference in the ESIAM series, where we could see several advances in fatigue design and lifetime prediction for AM metals, both on the test geometry as well as on the component level. Moreover, the field of polymer AM was significantly strengthened in 2021, where both aspects on fatigue and fracture were captured in presentations.

The event was planned to be held in Vienna, Austria, where Vienna University of Technology would have been kind enough to serve as hosts. However, it was decided in July 2021, two months before the event, that it had to be organized as virtual event due to the impact of the delta variant. We thank our Austrian friends and contributors for their hard work that was unfortunately not made visible due to this decision, which we all regret. However, despite it being held as virtual event, ESIAM21 could motivate 105 participants from 20 countries to present their work.

## 2. Topics

The number of submissions to the 5 most prominent topics represented in the conference can be seen in Figure 1. In total, there were 15 topics to be selected at the conference, which were

- Fatigue of AM Metals
- AM in Aerospace and Lightweight Design
- Characterization of Ceramic, Polymeric and Metallic Materials
- Fracture of AM Polymers
- Fracture of AM Metals
- Computational Property and Process Prediction
- Topology Optimization
- AM for Biomedical Applications
- Post Processing
- Non-Destructive Testing and Health Monitoring in AM
- Wear and Corrosion of AM Materials

- AM for Electronics and Photonics
- Metamaterials

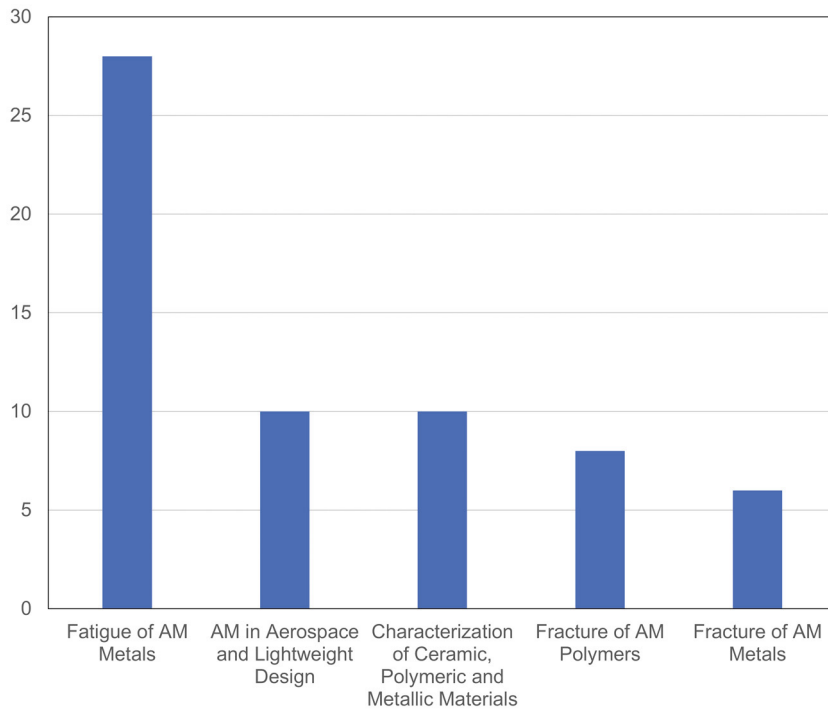


Figure 1: The 5 most prominent topics of the ESIAM21 conference in terms of the number of abstract submissions per topic

As in 2019, the fatigue of AM metals remained the most prominent topic of the conference with 28 submissions, followed by application-oriented submission towards Aerospace and Lightweight design as well as the characterization of AM materials. This shows the interest and importance of lifetime prediction and extension for AM materials, particularly metals, which will remain one of the most important issues to tackle by the ESIAM community.

Yet, the area of AM polymers also experienced a significant increase in representation, where both advances in fatigue and fracture assessment was presented. On the fracture aspect, submissions to AM polymers even exceeded those on metals.

### 3. Participating countries

The national distribution of participants can be seen in Figure 2. The increased attendance of participants from countries near Vienna, Austria, shows that the event was initially planned as physical event with Vienna as location. People in close proximity had the lowest risk of being restricted in travelling by COVID. Austria is leading the ranks with 21% of the total participants at the conference (22 abstract submissions) and Italy is on the second place (18%, 19 submissions). We are also pleased about the large interest from Belgium (13%, 14 submissions), where excellent contributions originated. The distribution is however heavily biased by the pandemic and does not give any indication of the leading countries in the field. The total number of participants and the spread would be different if the event would have been planned as virtual event to begin with.

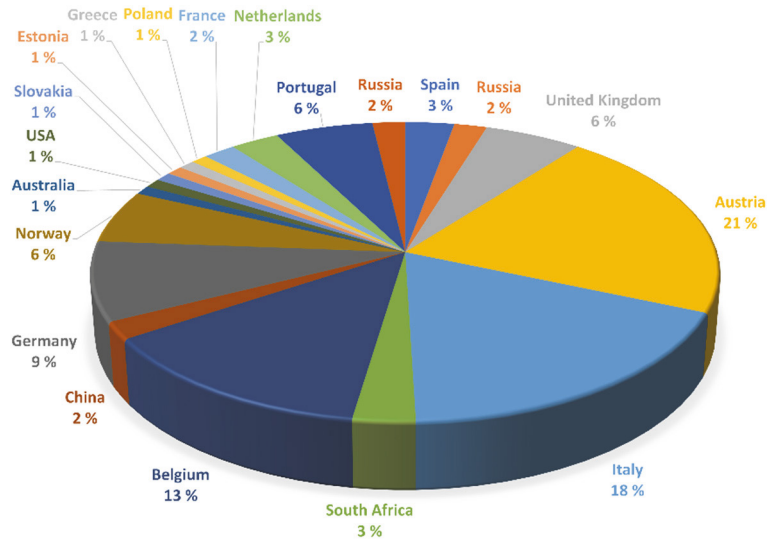


Figure 2: Distribution of the contributions to ESIAM21 per country

### 4. The Special Issue

The present special issue contains invited papers from the conference that were subjected to the standard peer review process performed through the Procedia Structural Integrity Editorial board. It contains articles representing the following topics

- Fracture of AM metals (8 submissions)
- Fracture of AM polymers (9 submissions)
- Fatigue of AM metals (10 submissions)
- Fatigue of AM polymers (4 submissions)
- Property simulation and design (7 submissions)

The focus of the special issue is fracture mechanics and fatigue, microstructure, and defect analysis of AM materials under different loading scenarios as well as the prediction of properties through simulation and the effective design for performance.

## 5. Concluding remarks

As guest editors, we want to express our acknowledgement to the authors, the reviewers and the editorial office staff that made this issue possible. We hope that the present issue provides a useful state of the art for engineers, academicians and industries involved in the challenges of producing high performance AM materials, from the test geometry level to the final parts. Within 2022, we will determine, where the next conference, ESIAM 23 will be held, on which, we will be very pleased to welcome you again, in person!

Sincerely yours,

The editors

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