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*Editorial*

# Advances in laser materials and processing technologies: An overview

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**Abstract:** Laser technology continues to be widely used in industrial terms in various manufacturing processes. This continuously leads to a significant flow of research into the most diverse aspects of this technology, namely in cutting, welding, texturing, engraving operations, and, more recently, three-dimensional (3D) printing of various materials. The most recent technological developments directly related to laser applications have led to new lines of research, which justify the development of some special volumes of high-quality research in this area of knowledge.

## 1. Introduction

Laser technology was studied intensively over the past few decades before entering some stagnation. However, recent developments around robotic welding [1–3], laser texturing and marking [4–6], laser cutting [7–9], and additive manufacturing [10–15] have led to a new wave of studies in this area of knowledge, which led to the creation of this Special Issue. In fact, the development of lasers whose wavelength is compatible with transmission through optical fibers has allowed for a wider range of applications, as it means that the generation system does not need to be placed at the end of the robotic arm, requiring more robust robots, or limiting the range of applications [16]. The texturing of very hard materials, namely ceramic composites used in cutting tools [17], has recently become an effective application of laser technology. This has the potential of improving the machinability of some materials as well as the marking of practically any material [18], allowing increased traceability by directly marking quick-response codes (QR codes) on the product.

Indeed, long gone are the times when laser technology was essentially used to cut the most diverse materials. Currently, laser technology is being investigated and used in the most diverse applications, from the medical field to the area of military defense or the monitoring of operations and processes. The evolution toward pulsed lasers and the development of more accurate control mechanisms have drastically expanded their application in industrial processes. This has created countless research opportunities aimed at characterizing and optimizing their use with different materials and understanding the phenomena associated with their application.

## 2. An overview of this Special Issue

The evolution and volume of research linked to laser technology justifies the publication of this Special Issue, which presents some of the most recent technological advances in laser applications in materials and nanofabrication processes. Two excellent articles on laser applications are part of this volume. One is aimed at the application of laser by the holographic method for stress verification in polymeric materials [19]; the other demonstrates the optimal parameters of laser marking on composite materials to obtain surfaces with high roughness that are visible to the laser reader [20].

The first work, published by da Silva et al. [19] and titled “Holographic method for stress distribution analysis in photoelastic materials”, focuses on a polymer sample and generates three independent waves polarized at 45, 0, and 90°, producing two distinct holograms resulting in interference patterns. The optical information obtained through photoelasticity is used to derive the stress-optic law, which is implicitly correlated with the holographic method. Finally, the Fresnel transform is applied to digitally reconstruct and obtain the demodulated phase maps for compression and decompression and finally calculate the Poisson’s coefficient of the material. The results demonstrated that the stress distributions derived through holography were more accurate and reproducible than those obtained via photoelasticity when compared with theoretical results.

The second paper, published by Sales-Contini et al. [20] and titled “Influence of laser marking parameters on data matrix code quality on polybutylene terephthalate/glass fiber composite surface using microscopy and spectroscopy techniques”, performs a detailed morphological analysis of the surface of the neodymium-doped yttrium-aluminum garnet (Nd:YAG) laser-marked composite material. Process parameters were selected, and laser-marked data matrix codes (DMCs) were analyzed to assess quality according to ISO/IEC 29158:2020 standards; this was combined with a detailed surface analysis to observe physical and chemical changes using scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). This work complements the previously published results by Sales-Contini et al. [6].

Two other articles involve nanofabrication processes: a review article published by Equbal et al. [21] and another one, published by Dawood and AlAmeen [22], that presents recent findings in the study of fatigue and mechanical properties of specimens produced by three-dimensional (3D) printing. The first presents a detailed study of recently (from 2020 to 2024) published works in fused deposition modeling (FDM) collected from Scopus and Web of Science data using “FDM” and “dimensional accuracy” as keywords. The study mainly focuses on the improvement of process accuracy over 4 years of research and studies the main factors that can interfere with the printing quality of components during the use of the FDM additive manufacturing process. The most recent work presents the fatigue study of carbon fiber-reinforced polylactic acid (CF-PLA) composite samples manufactured with three different 3D printed patterns: gyroid, tri-hexagon, and triangular with three different infill levels. The mechanical properties of traction, flexure, and impact were systematically obtained, and the durability of the material was analyzed by fatigue tests. The results demonstrated that the gyroid infill pattern had the best performance; also, by increasing the infill rate, it was possible to obtain an 82% increase in the ultimate tensile strength. This study demonstrates the applicability of different types of infill to obtain the best mechanical properties, reducing material use and being a sustainable process.

## 3. Conclusions

Research into laser technology is still very much alive and increasingly diverse, given the expansion of fields of application. This Special Issue presents some of the most recent developments around this technology, hoping that they can be of great use to the scientific community.

## Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

## Authors contribution

Writing draft and review: F.J.G-Silva and R.C.M. Sales-Contini.

## Conflict of interest

Francisco J. G. Silva and Rita C. M. Sales-Contini are on a special issue editorial board for *AIMS Materials Science* and were not involved in the editorial review or the decision to publish this article. All authors declare that there are no competing interests.

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