

# Influences of the additive manufacturing PBF-LB parameters: residual stresses and thermal distortions of AISI 316L stainless steel and Ti6Al4V parts.

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## Abstract

**Statement of the Problem:** Additive manufacturing has become popular in recent years due to advantages such as rapid prototyping, use of optimized and complex shapes, reduced unit cost and parts with significantly lower masses. However, the main disadvantages are distortions and the generation of residual stresses due to thermal effects resulting from the process. In view of these disadvantages, this research project aimed to numerically model through the Finite Element Method (FEM) the distribution of residual stresses and thermal distortions in parts generated by Selective Laser Melting in Powder Bed (PBF-LB – Powder Bed Fusion-Laser) of stainless steel AISI 316L and in titanium alloy Ti6Al4V, through the MSC Simufact Additive software and validate the results obtained through experimental measurements in previously manufactured parts. The influence at three levels was verified through a complete factorial planning of some manufacturing parameters such as laser power, speed and distance between scans (hatch), in the results of residual stresses and distortions of samples printed in the OmniSint-160 equipment and also in the samples simulated in the MSC Simufact Additive software. When the experimental and numerical results are compared for measuring the mean diameters of the 316L samples, a relative error of less than 2.5% was observed, while for the Ti6Al4V samples the maximum error was less than 4.5%. When the experimental and numerical results are compared for the measurement of the lateral residual stresses of the 316L samples, it is observed that the maximum relative error was less than 12%, however, in most cases it was less than 1%, while for the Ti6Al4V samples the relative error was less than 9%, however, the majority was less than 2%. In general, it is possible to conclude that the computational modeling accompanied by measurements and calibrations carried out in the experimental stages proved to be efficient and assertive, making it possible to reproduce the thermal distortion and residual stresses with statistical confidence both for the 316L stainless-steel samples and for the Ti6Al4V titanium samples.

## Recent publications:

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2. Appiah Augustine, Woźniak Anna, Snopiński Przemysław, Matus Krzysztof, Nuckowski Paweł, Ferreira Batalha Gilmar, Nazarov Shuhratjon Abdugulomovich, Ganiev Izatullo Navruzovich, Adamiak Marcin: Vanadium-induced structural effects on the corrosion and tribological properties of an Al-Li binary alloy, *Journal of Alloys and Compounds*, vol. 973, 2024, Article number: 172910, pp. 1-15, DOI:10.1016/j.jallcom.2023.172910,
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5. Adamiak Marcin, Appiah Augustine, Żelazny Radosław, Ferreira Batalha Gilmar, Czupryński Artur: Experimental comparison of laser cladding and powder plasma transferred arc welding methods for depositing wear-resistant NiSiB + 60% WC composite on a structural-steel substrate, *Materials*, MDPIAG, vol. 16, no. 11, 2023, Article number: 3912, pp. 1-25, DOI:10.3390/ma16113912.

## Photograph



## Biography

Gilmar Ferreira Batalha obtained his diploma for mechanical engineering at the University of Brasilia (Brazil) in 1983; a Master of Science degree in mechanical engineering at the Federal University of Santa Catarina, Florianopolis (Brazil), in 1987; a doctorate in promotion mechanical engineering (Dr. Engineer) in 1996; and the title of free-docent in 2010, with the latter two both obtained at the Polytechnic School of the University of São Paulo. From 1984 to 1989, he was an adjunct professor at the State University of Santa Catarina in Joinville, Brazil. Since 1989, he has been a tenured associate professor in the Dept. of Mechatronics and Mechanical Systems Engineering at the Polytechnic School of Engineering of the University of São Paulo. He is a Master's-grant-awarded fellow of the Brazilian National Committee of Nuclear Energy (CNEN); recipient of a CAPES postdoctoral internship at the Manufacturing Institute of Technology (Lehrstuhl für Fertigungstechnologie, LFT, Friedrich Alexander Universität Erlangen Nürnberg, Bayern, Germany) (1997–1999); visiting professor at the Ecole Centrale de Lille, France (2004–2006); invited visiting professor at the Technical University of Silesia, Gliwice, Poland (2012); and associate editor of *Archives of Materials Science and Engineering*, an MDPI periodical..

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