Maturing Additive Manufacturing PBF-LB technology for space applications: a timeline analysis on functional and structural application cases

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Additive Manufacturing (AM) technologies have shown to be capable of producing space hardware for functional and structural applications, tackling different materials and methods which have been uses for critical and non-critical parts. This is clearly pushed by the outstanding benefits that can be achieved due to the increased functionality of the produced parts as well as the capability of reducing lead-time and mass. The last is of particular interest in the space industry, where the cost for delivering 1Kg of payload range from about 10-20k€.
Powder bed fusion laser-based (PBF-LB) is largely the most AM process applied in the space industry due to (i) the acquired knowledge for processing different metal alloys, together with the required thermal treatments and definition of allowables for each material and condition; (ii) the maturity of the technology, which has evolve for producing more robust manufacturing systems, capable of obtaining repetitive mechanical/microstructural/etc. characteristics in the different alloy systems; (iii) the development of post-processing strategies such surface finishing treatments, I/F machining methods, etc., and (iv) the implementation of inspection methods like computed tomography depending on the part criticality. Thanks to that, there is available today an ESA ECSS which defines requirements for processing and quality assurance of powder bed fusion technologies for space applications (ECSS-Q-ST-70-80C) based on the industry and ESA lessons learn and requirements.
This work covers relevant aspects for the development of metallic space hardware manufactured by CATEC using PBF-LB process in AlSi10Mg, Al-Mg-Sc and Ti6Al4V alloys, for different missions like PROBA3 satellite with a functional helix antenna (in collaboration with SENER), the production of optimized CSS supports for a south-american observation satellite (in collaboration with INVAP), the development of the panels' supports for Eutelsat-QUANTUM satellite (in collaboration with AIRBUS Space System), and the JUpiter ICy moons Explorer spacecraft (together with CiTD, CTA, and coordinated by AIRBUS and ESA). Also, other aspects covering the first steps produced validated hardware at TRL6 are presented, like a clampband for VEGA launcher (in collaboration with AIRBUS) and optimized generic launcher connector support (with CiTD and AIRBUS). Different production steps are addressed, starting from the design, followed by fabrication, post-processes and finalizing by the description of inspection methods, and with a timeline perspective