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Author: Ms. Tanya Scalia
Italian Space Agency (ASI), Italy

Ms. Lucia Bonventre
Italian Space Agency (ASI), Italy
Mr. Pasquale Vecchiarelli
Italian Space Agency (ASI), Italy
Dr. Marco Pizzarelli
Italian Space Agency (ASI), Italy

ADDITIVE MANUFACTURING: SCIENTIFIC & PATENT TRENDS IN THE SPACE SECTOR

Abstract

Additive Manufacturing (AM) has emerged as an attractive key technology for space industries. The AM approach, based on a part production through a layer-by-layer building, has found increasingly fertile ground in the manufacturing of space components leading to a significant reduction in material waste, lead time and energy use. AM is not a single process, but a group of processes related to each other, and the main advantages when compared to traditional manufacturing (e.g. forging, casting) are related to lower cycle times, cost reduction, design freedom and performance improvement. These potentials make AM an appealing method in aerospace engineering, where the combination of reliability, feasibility, dimensional accuracy and high rate production are the key strengths in the manufacturing processes. With specific focus in the aerospace industry, there are still many limitations in additive manufacturing production techniques, such as the lack of globally recognised standards and certifications, the cost of AM processes or the quality control of the metallic powders. However, the growing needs for technologies for manufacturing on-ground, in-orbit and on moon or planetary bodies (including ISRU) is also reflected in the new release of the ESA Technology Tree (v 4.0 - April 2020), which has included specific areas dedicated to this topic in the "Materials and Manufacturing Processes domain". In this paper we present the development of AM for space applications in terms of scientific publications, patent families and market trends in the field of lightweight structure, optimised design, hybrid manufacturing, in-space manufacturing and planet explorations. Such patent and literature indicators, integrated with market information, provide a clear evaluation of the related technology trends and readiness levels of additive manufacturing in the space domain. Such area may include different materials, such as metallic, ceramic and plastic parts, manufacturing techniques, etc. By using specific sectoral keywords, we analysed patent families and scientific publications for the period 2010–2020. We identified, among others, the global trends, the International Patent Classifications (IPC), the geographic distributions, top assignees and funding sponsors, etc. As a result, we identified that both scientific literature and patents have witnessed a significant increase for the period under examination. United States and China maintain the highest positions in both scientific literature and patenting activities. Similarly, Europe (particularly Germany, Italy, and France) and United Kingdom are very active. Major aerospace players (e.g. Airbus and Boeing) show significant patenting activity. 3D printers and additives are among the most recurring technology domains.