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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialised Technologies, Including Nanotechnology (8)

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ADDITIVE MANUFACTURING FOR SPACE INSTRUMENTATION AND SUBSYSTEMS

Abstract

In the frame of various projects, CSL has studied the capabilities offered by advanced manufacturing technologies for various space applications, by addressing the end-to-end manufacturing process, starting from early design phase till functional testing of the part. Among these, Additive manufacturing (AM) turned out to be quite promising. Since then, new projects and PhD research work that aim at demonstrating the applicability and potential benefits that could be brought AM technologies, especially in the field of space instrumentation, are currently underway.

In this framework, specialized materials with the combination of high specific stiffness and extremely low coefficient of thermal expansion that would provide a robust solution against both temperature changes and gradients are ideal for building super-stable lightweight skeletons. The before-mentioned rationale makes some technical ceramics a reference material to achieve the stringent thermo-elastic performances of space optical payloads.

The demand in using technical ceramic materials in space applications is largely increasing, since they combine extremely interesting properties in terms of structural, thermal, but also electrical performances. Today, new manufacturing routes are possible which could allow significant costs reduction in ceramics production, and potentially opening the products/applications portfolio (compact electrical circuit, integrated heat pipes, multifunction materials and panels, etc.) in symbiosis with AM design features.

Stereolithography and Binder Jetting principles have been identified as the two possible routes for shaping complex ceramics components, with advantages and disadvantages for both techniques depending on the requirements imposed. With regards to opto-mechanical sub-systems (optics, baffling, optical bench, etc.) a system-level methodology is being put into place, and necessary developments are being made accordingly.

In particular, the development of a novel end-to-end manufacturing route for functional optics and components made of Silicon Nitride grades has been initiated in collaboration with CERHUM. Using a stereolithography-derived printing process, a ceramic green part is manufactured by layer-wise curing of light-sensitive ceramic slurry through selective irradiation and photo-polymerization. After removing the excess slurry, the green part is debinded and sintered to an almost fully dense ceramic part. The component is further post-processed to get the functional part.