AEROSPACE ENGINEERING

DIMEAS - Numerical simulation of burnback in solid rocket motor grains produced by additive manufacturing

Funded By	Dipartimento DIMEAS
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Context of the research activity	The research activity will be devoted to the development of methods and tools to simulate the burnback in solid rocket motor propellant grains. The work will be focused on the implementation of the level set method in a high performance code which can exploit the new generation of hardware architecture. The activity will be integrated with the development of new optimization paradigms to explore the potential of solid propellant grains produced by additive manufacturing.
Objectives	The use of additive manufacturing in the production of solid rocket motor grains paves the way to the development of new rocket propulsion systems with some significant advantages. First of all, the production process of classical composite propellants requires the use of toxic isocyanates which control the curing of the binder: some additive manufacturing techniques have to potential to avoid isocyanates, limiting the safety and environmental concerns in the production process. Furthermore, the great flexibility of additive manufacturing paves the way to the development of new designs which can go over the limitations of grains produced by standard casting techniques. The research activity will be focused on the development of the numerical methods and tools which are necessary to explore the potential of these new solutions. In particular, the simulation of the grain burnback will be performed by the classical level set method implemented in a high performance numerical code which will exploit new generation hardware, like Graphics Processing Units (GPUs). This simulation tool will be exploited to develop an optimization framework to design new configurations. Particular attention will be devoted to the development of machine learning and multifidelity techniques to support the design process and to maximize its efficiency.
Skills and competencies for the development of the activity	The candidate should have a solid background in rocket propulsion, fluid dynamics and thermodynamics. Knowledge of the main algorithms used to integrate partial differential equations is required, as well as practical experience in running Computational Fluid Dynamics (CFD) simulations. A solid background in programming, machine learning and multi-fidelity methods is required.