AEROSPACE ENGINEERING

117/CIRA -Multi-disciplinary methods&tools for flexible thermal protection systems for inflatable or deployable heat shields of space re-entry systems

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Context of the research activity	The research topic concerns the development of multi-disciplinary methods and digital tools to support the design of flexible thermal protections for re-entry vehicles. The study focuses on two main functions of heat shields, the capability of preserving the underlying structure and the flexibility, for both deployable and inflatable systems. The study can be supported by experimental tests, like high temperature and bendability tests, in addition to specific tests may on samples of materials. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001970004
	The enormous growth in the demand for access to and exploitation of space requires the rapid development of technological solutions aimed on one hand to promote the competitiveness in a sector where other countries (i.e. United States) have consolidated and expanded a significant advantage over Europe, and on the other hand to foster economic and environmental sustainability of new technological solutions. In this scenario, the development of technologies that allow for low-cost recovery of stages/elements of launch systems and/or satellites/payloads from low Earth orbit assumes a key role. The research topic concerns the development of multi-disciplinary methods and digital tools to support the design of flexible thermal protections for re-entry vehicles. The study focuses on two main functions of heat shields: the primary function of preserving the underlying structure and the flexibility. As far as the first function is concerned, the thermal protections for deployable systems and for inflatable systems shall meet substantially different requirements. In deployable systems, the structural configuration of heat

Objectives	shield to guarantee the necessary mechanical strength to withstand aerodynamic loads with acceptable deformations is not widespread. In inflatable systems, on the other hand, the structural configuration of flexible heat shield is widespread and shall guarantee a thin-walled, porous layer with almost zero thermal capacity. As far as the flexibility function is concerned, this is essential for the folding of heat shield during launch and prior to re-entry. The modeling, which can also exploit commercial calculation codes, shall be able to evaluate the volume occupied by the folded thermal protection, based on both the physical characteristics of the materials and the folding strategy. The study can be supported by experimental tests in the context of other projects, both high temperature tests and bendability tests. Specific tests may also be conducted on samples of materials identified during the research activity. The study will also devote part of the resources to a screening of flexible materials suitable for use for flexible protections and their classification in terms of flexibility and ability to protect against heat. The proposed topic therefore fits perfectly within the PNRR Mission 4C2 "From Research to Business", Investment 3.3, responding to the needs of CIRA in the field of designing innovative and sustainable space transport systems. Furthermore, the proposed topic is in line both with Mission 1 of the PNRR "Digitalisation, Innovation and Competitiveness in the Production System", contributing to the increase of competitiveness in a strategic sector, and indirectly with Mission 2 "Green Revolution and Ecological Transition ", due to the reduction in the volume of launchers to be produced.

Skills and competencies for the development of the activity	High-speed and high temperature systems. Re-entry missions.