Progetto di ricerca

Valutazione numerica e sperimentale delle prestazioni di materiali compositi a matrice metallica per applicazioni aerospaziali

Performance limitations of conventional materials stimulate the spreading of composite material, a term which comprises a wide range of combinations of different materials as e.g. reinforced plastics, reinforced metals, metal matrix composites and further hybrid materials consisting of at least two separated phases. Powder metallurgy is a widely used and efficient way of metal matrix composite formation, which can provide new solutions. For the fundamental understanding of how these new innovative materials systems behave in operational environment, the development of advanced metal matrix composite materials will be done by rational design, with focus on the combination of theory with large-scale computational screening and multiscale modelling. Extensive pre-analysis will be followed by lab-scale production and testing. Such bottom-up approach is particularly needed when aiming at innovative material systems that conjugate optimal performance in highly demanded aerospace conditions with sustainability requirements.

The activities will regard the development and study of advanced materials for structural, thermo-structural and functional applications, with an interdisciplinary approach particularly addressed to the introduction of new products into the market or the improvement of the production processes. These goals are achieved by optimizing the structural and/or functional properties that are closely related to the process conditions for their production. The CIRI Aerospace considerable experience in engineering of advanced metal matrix composites will be exploited in order to focus on design and applications of advanced design of metal matrix composites (theory and FEM analyses), coupled with innovative technologies as Additive Manufacturing and Laser Peening.

Within the proposed workplan, aluminium based hybrid composites will be manufactured from different kind of aluminium alloys and ceramic particles. The residual stress distribution within the produced specimen will be accurately determined using a non-destructive (sample cutting-free) X-ray Diffraction and Tomography techniques. Microstructure and mechanical properties of the specimens will be revealed afterwards. Specimens will be produced with varying process parameters to reveal the correlation between manufacturing parameters, residual stress and microstructure.

Piano di Attività

Titolo del Progetto di ricerca:

Valutazione numerica e sperimentale delle prestazioni di materiali compositi a matrice metallica per applicazioni aerospaziali

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SSD: ING-IND/04 – Costruzioni e Strutture Aerospaziali

Le attività relative al Progetto di ricerca si articolano secondo i seguenti punti:

1. Analysis of the lightweight materials, metal matrix composites requirements for space and aeronautical applications.
2. Manufacturing of aluminium based hybrid composites from different kind of aluminium alloys and ceramic particles
3. Application of analytical and numerical full-scale 3D characterization methods.
4. Numerical multiscale modelling of novel complex metal matrix composite material systems.
5. Experimental determination of the residual stress distribution within the produced specimen by using non-destructive (sample cutting-free) X-ray Diffraction and Tomography techniques.
6. Investigation on the correlation between manufacturing parameters, residual stress and microstructure.