Innovative and Sustainable Metallurgy in aeronautics: status, development opportunities and challenges

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Abstract Innovative and advanced materials have been for years the heart of research and development efforts in the aeronautics industry, to address intricated objectives such as weight reduction in turbo-engine, reduced pollutant (CO2, NOx) emissions, reduction of energy consumptions in service and during production steps as well, without impeding the safety of operations. In many cases, technological breakthrough are necessary, which are mainly visualized by architecture or design evolutions, which relies themselves on new materials and/or processes.

This presentation will start by exemplifying the different topics that were research in the past year in the aeronautic community in general, and at Safran in particular, with an explanation on the process evolutions, the projected impact of the technology on applications and actual technical locks that have to be faced. In more details, a special emphasis will be laid on Powder Metallurgy processes, rejuvenated by the development of Additive Manufacturing, and the new potential bring by powder quality improvements. Furthermore, an analysis of actual status for high temperature systems, such as refractory alloys, new superalloys or composite-based technologies will be discussed.

On a second part, a deep dive will be performed on Ti-based intermetallics. The improved specific mechanical properties of these alloys, when compared to Ni-based superalloys, have pushed Safran and other major aero-turbine producers to develop and to introduce them in their newest generations of turbines. Nevertheless, despite clear advantages, not all of them are a reality for mass production and the case of TiAl and Ti2AlNb intermetallic systems will be used to exemplify this aspect.

The industrialization steps for TiAl alloys in actual aircraft engines will clarify the importance of choosing adapted processing routes for complex parts production, and its strong interlinking with final properties and design. A specific section will focus on new Powder Metallurgy routes and their application to industrial parts. Material microstructures and properties will be compared to other processes, but also its energy consumption will be discussed. The final part of the presentation will be dedicated to the development status of the Ti2AlNb alloy system and the potential applications targeted in agreement with their actual properties. Remaining challenges in the development of these alloys will be emphasized and discussed.

In term of perspectives, new challenges associated to materials and processes for hybridization of the airplane structure will be pointed out.