PhD proposal
Development of high-temperature oxidation resistant system on Titanium Aluminide (Ti-Al) alloys

Context

With a density twice lower than nickel-based alloys, similar mechanical properties and an acceptable oxidation resistance, the use of intermetallics γ-TiAl for low pressure (LP) turbine blade application appears promising for a significant weight reduction for next generation engines. Today, most of the applications involving γ-TiAl alloys do not exceed 750°C due to mechanical and environmental limitations of this type of material.
As the increase of the operating temperature is a strong point to improve the efficiency of the next generation of aircraft engine, the temperature of all hot section will gradually increase. The low pressure turbine will also be concerned by this temperature increase and the improvement of high-temperature resistance of TiAl alloy LP blades appears essential. For operating conditions over 750°C TiAl alloys are subject to environmental degradation due to the low TiAl oxidation resistance. In addition, oxidation has a negative impact on the mechanical properties. TiAl alloys suffer from ductility loss at room temperature after an exposure at high temperature.

Objectives

The aim of this work is to develop a new generation of TiAl material/coating system. To reach this target surface engineering appears to be the key to success for improving the high temperature resistance of such materials.

Activities:

1) Identification of material and process: Literature review on the base material, on anti-oxidation process/coating, identification of potential material/process
2) Process development of the coating: investigating surface pre-treatments and coating application processes. Analysis techniques: Microscopies, EDS, XRD, EPMA, XPS, PIGE…
3) Coating characterization and testing, including understanding of protection and oxidation mechanisms: oxidation resistance, influence of environmental conditions on coatings properties, impact on substrate material (microstructure, mechanical): Techniques: SEM, XRD, TEM, nano-indentation, 4 points bending fatigue, tensile testing, cyclic oxidation tests.
4) Report

Candidate Profile:

Engineer/Master in Materials Science or related speciality with good knowledge in materials microstructure-mechanical properties relationship, autonomous and good team worker, curious and innovative.

Language :

English (Fluent)

Specifics :

The work will take place mainly at the Research Center of Dechema (Frankfurt, Germany) and Safran Research Center, Safran Tech (Magny-Les-Hameaux, île de France) with some analysis at CIRIMAT laboratory (Toulouse, France)

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