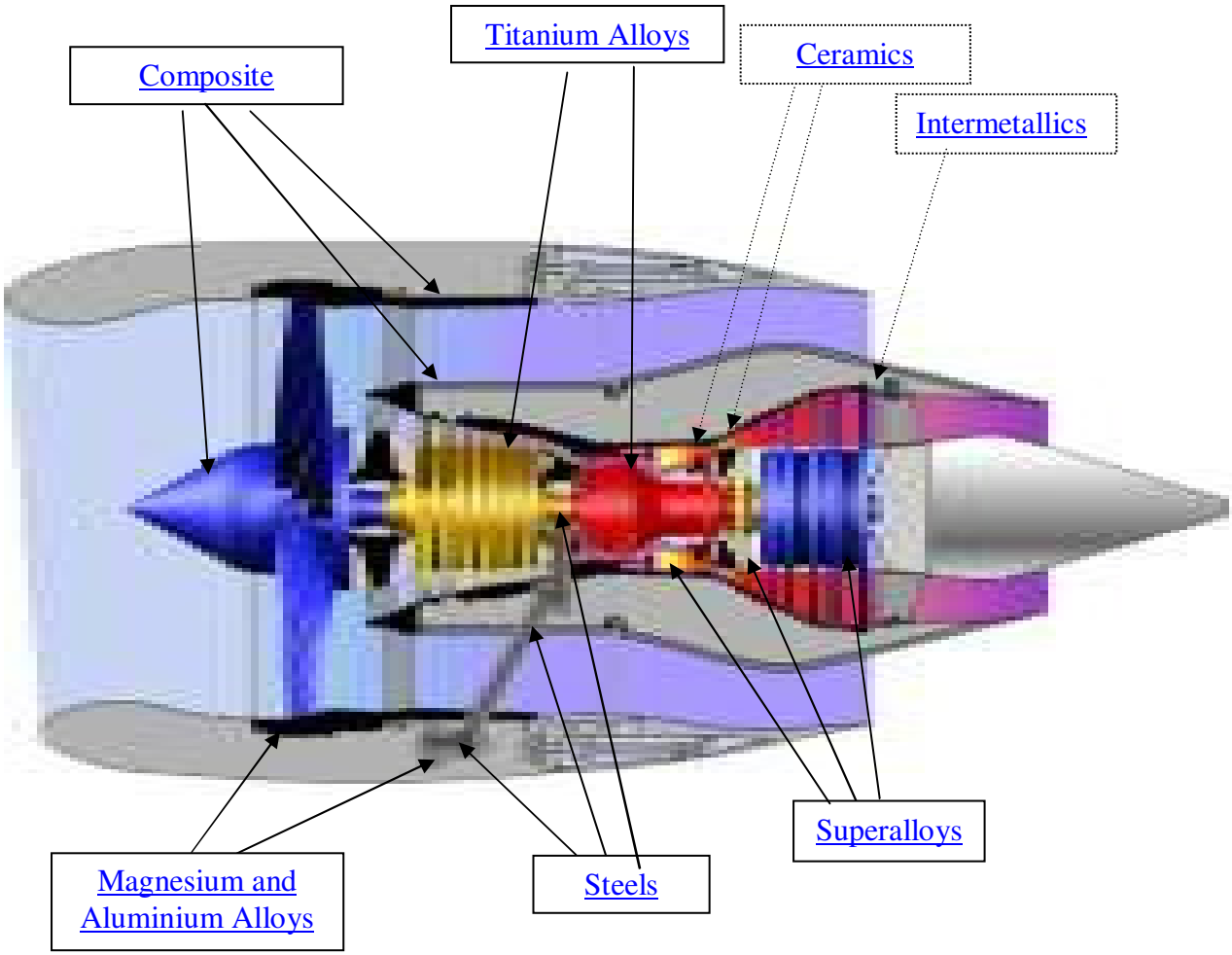

Titanium Alloys
Composite
Ceramics
Intermetallics
Superalloys
Magnesium and Aluminium Alloys
Steels

Polymeric Materials Composite (PMC)

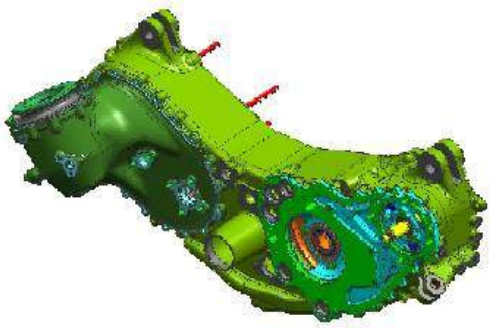
The composite materials to reinforced polymer matrix by fibres are particularly attractive for the extreme lightness and high specific strength, and are already wide used in the aircraft structures. The use on aeronautical engines now is limited by temperature resistance (approximately 200 °C for epoxy resins), but the use is quickly increasing and already now new fans and containment systems of first stages of compressors are realized in composite.

Altogether composite materials represent currently 5% of engine weight

R&D Activity on Polymeric Composite Materials

R&D Activities on Polymeric Composite Materials

The Avio R&S activity on polymeric composites material was addressed to exploration of possibility to use in the mechanical transmissions, and in particular to the material properties evaluation after exposure to high temperature and compatibility with the lubricating oil.



Aluminum and Magnesium Alloys

The magnesium and aluminium alloys (light alloys) can be realized in complex forms with relative easiness, through cast in sand processes or through forged bars mechanical working. The greater use limitation in the aeronautical engines is given by maximum use temperature, that very rarely exceeds 220 °C in the aluminium alloys case, or 250 °C in the Magnesium alloys case. They are mainly used for manufacturing of mechanical transmissions casing.

The light alloys represent approximately 5% of engine weight.

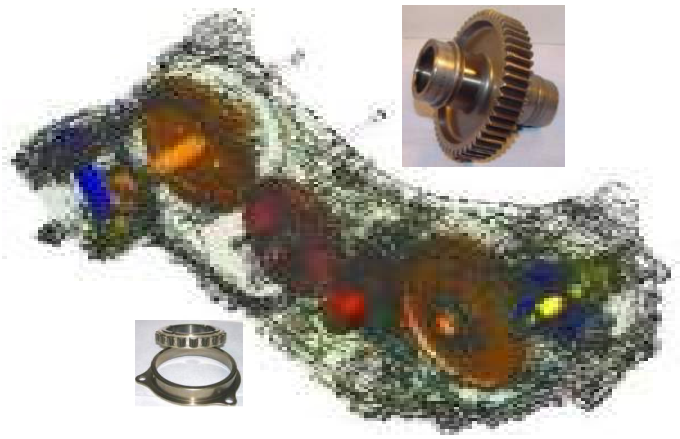
R&D activities on Light Alloys

R&D activities on Light Alloys

The Avio research activities on light alloys was addressed to new magnesium alloy characterization much more corrosion resistant and high temperatures use, to evaluation of effects of some binder elements on aluminium alloys mechanical properties, to effect evaluation of defective that can be found on casting on characteristics of components use.

Steels

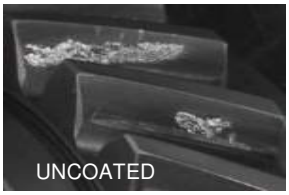
The steels are normally used for realization of shafts and gears of mechanical transmissions, bearings and compressor parts. Their main limitation is due to the temperature, than in casehardened steels case it cannot exceed 250 °C, while for other high resistance special steels or for some stainless steel it can arrive to approximately 600 °C
Steels represent currently 15 - 20% of engine weight.

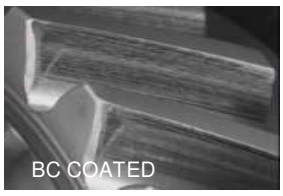


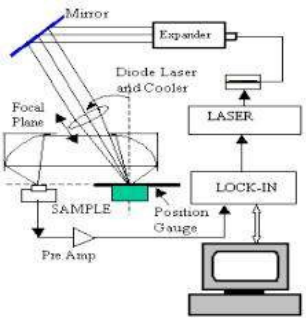
R&D Activities on Steels

R&D Activities on Steels

They were addressed to evaluation of new casehardening steels for high temperature use, to nitriding steels for deep nitriding, to identification of non-destructive testing for depth of hardening measurement, to alternative heat treatments evaluation, to superficial finish processes lined up and coatings able to improve duration and wear performance.



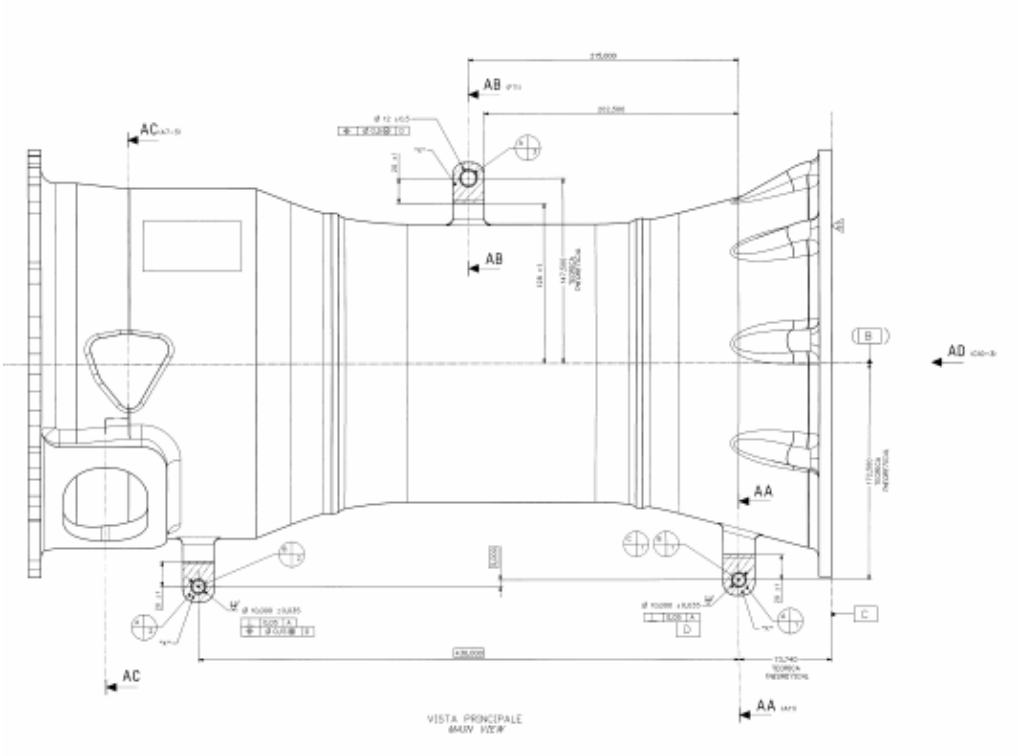




Titanium Alloys

The Titanium alloys are characterized by a specific weight much low and can be used for temperatures relatively high, till approximately 450 -550 °C.
The titanium alloys are typically used in compressors discs and blades manufacture and in some important components of power mechanical transmissions when particular lightness requirement are required.
Titanium Alloys represent currently 25 - 30% of engine weight.

R&D Activities on Titanium Alloys



R&D Activities on Titanium Alloys

N/A

Superalloys

The superalloys are complex alloys, constituted mostly by Nickel (or Cobalt) with addition of many other elements (often also more than 10), and are characterized by high mechanical property to high temperatures.
Just for their elevated resistance to high temperature, the superalloys are wide diffuse in aeronautical engines, from final stages of compressors (when temperature is too much high for Titanium alloys), to combustors and reheats (in military engines), to turbines and engine casing.
Superalloys represent currently 40 - 50% of engine weight.

Combustors and reheats are the components which reach the most elevated temperatures. For their realization, particular superalloys have been developed with high mechanical strength not too much high but with high resistant to the oxidation, easily machinable, moldable and weldable.
R&D Activities on Superalloys for Combustors

Disks are among the components more critical of aeronautical engines, and for this reason they are manufactured with materials "premium quality" using elaboration methods and constructive technologies extremely controlled and that guarantee an elevated level of quality and performances. The superalloys used are issued of high mechanical strength and oligocyclic fatigue until to temperatures of the order of 600 - 650 ° C.
R & D activities on Superalloys for turbine discs

The superalloys used for stator and rotor turbine blades are casting alloys which possessing high strength thermo-mechanical and viscous flow to the hot (creep) until temperatures close to 1100 ° C. The hottest parts of the turbines are made by techniques of directionally solidification (DS) or single crystal (SC).
The superalloys start to be sensitive to the phenomena of oxidation and hot corrosion when temperatures of work rise over 750 ° C. In these cases, the life of the components can be significantly improved through the application of protective coatings and thermal barriers.
R & D activities on Superalloys for Blades Turbine

R & D activities on Superalloys for combustion chambers and after-burners.

The R & D activities on materials for combustion chambers and after-burners are mainly aimed to the mechanical characterization of superalloys potentially usable, and evaluation of new manufacturing systems direct of injection systems with based Cobalt – Chromium alloys.

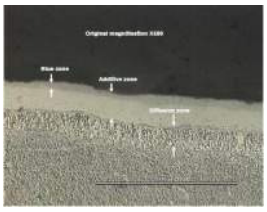
R & D activities on Superalloys for turbine discs

The R & D activities on superalloys discs were essentially addressed to the evaluation and characterization of new materials that can further increase the temperature of use of turbine disks without having to resort to materials obtained by powder metallurgy.

R & D activities on Superalloys for Turbine Blades

The activities on superalloys for turbine blades were aimed to evaluating of new single crystal superalloys or directional solidification which can withstand temperatures on work increasingly high. More recently, the tests have been sent to evaluation of superalloys lighter and without strategic elements and to assess the effects of heat treatment on mechanical properties.

Another investigation field concerns the evaluation of new protective coating against hot oxidation and corrosion more efficient and inexpensive, and the study of new thermal protection systems with the use of ceramic thermal barriers.



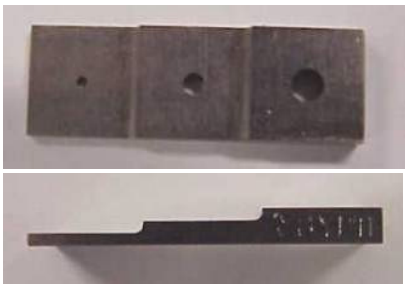
Ceramic

The ceramic materials are particularly attractive for low density (less than 3 g/cm3) and high resistance to high temperature. To extend their use, currently limited to a few components of certain military engines, have yet to be solved several problems related to high brittleness, low resistance to heat loads, sensitivity to degradation in presence of oxygen and steam at high temperature, the high cost of implementation.

R & D activities on Ceramic

Activities of R & D Ceramic Materials

The R & D activities on ceramics in Avio are mainly addressed to increasing knowledge about this type of material, to understand the characteristics, properties and limitations of use, to evaluate the typical defects, to identify the most suitable design solutions to interface with metal components.



Intermetallic materials

Interest in the intermetallic materials has grown in recent years, despite the inherent fragility of such materials, especially for the high potential savings in weight achievable.

The intermetallic materials more attractive are TiAl alloys used in place of base Nickel superalloys for the cooler turbine components, until to temperatures of about 650 ° C. GenX engine is the first civilian engine which uses TiAl intermetallic rotor blades of the last stage of low pressure turbine.

Other intermetallic materials potentially interesting are the intermetallic based Nickel Aluminum, which although limited benefits for reduced weight compared to TiAl intermetallic are potentially suitable for use at high temperatures (over 1100 ° C).

R & D activities on intermetallic materials

R & D activities on intermetallic materials

The R & D activities in Avio on intermetallic titanium alloys - Aluminum have targeted the evaluation of methods to manufacture more suited to the implementation of specific components of interest (low pressure turbine), the development of heat treatment to obtain optimal microstructure, the evaluation of mechanical properties, including in relation to possible defects, to the techniques of joint.

Have been also setted activities for the preliminary assessment of intermetallic alloys type Nickel - Aluminum