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Advancement in the Materials Used In Aircraft-A Review

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Abstract
This paper describes about the advanced materials used in aircraft, aircraft body, aircraft engines etc. So many researches are going on the advancement of materials for aircraft. For the Aerospace Engineering applications there is huge upgradation in the field of material science structure and engineering with the technical related to progress in advanced materials. This paper gives a clear picture of aircraft materials which were used before and which are in use at present.

Keywords: *Composite materials, Fibre-reinforced polymer, Thermal Barrier Coatings, Aerospace systems, Aerospace applications, GE aircraft engine, ALLVAC 718 plus super alloy, Fiber Bragg Grating (FBG).*

INTRODUCTION

Aerospace Engineering has actually the backer for the development of advanced engineering materials. The advanced material progress hang on their properties such as, Strength, Stiffness, Toughness, Damage tolerance, Density, and Corrosion resistance at ambient and high temperatures.

Composite Material: A composite material is a combination of two or more materials, combined to obtain specific property that cannot be obtained from a single material and these materials are combined together to create superior and unique materials. The materials used in composites are classified into two types i.e. matrix and Reinforcement. The reinforcement provides the toughness and rigidness which helps to support the structural loads. The matrix also called as binder, helps to maintain the position and orientation of reinforcement. The rapid progress and use of composite materials beginning in the 1940s had three main operating forces. Military vehicles, such as airplanes, helicopters, and rockets, placed a bonus on high-strength, light-weight materials. While the metallic components that had been used up to that point certainly did the job in terms of mechanical properties, the heavy weight of such components was restrictive. The heavier the weight of the plane or helicopter itself, the less freight its engines could carry.

Polymer industries were rapidly growing and tried to elaborate the market of plastics to a variety of applications. The appearance of new, light-weight polymers from development laboratories offered a possible answer for a variety of uses, provided something could be done to enlarge the mechanical properties of plastics. The very high theoretical toughness of definite materials, such as glass fibres, was being uncovered. The question was how to use these capable high-strength materials to unfold the issue posed by the military's demands. One may appropriately speak of four generations of composites:

First Generation (1940s): Glass Fiber Reinforced Composites
Second Generation (1960s): High Performance Composites in the post-Sputnik era
Third Generation (1970s & 1980s): The Search for New Markets and the Synergy of Properties
Fourth Generation (1990s): Hybrid Materials, Nano composites and Biomimetic Strategies.

The usage of high performance composite materials to military aircraft can be tracked back almost three decades to the F-14 (US Navy) and F-15 (US Air Force) fighters, which use boron/epoxy hull in their empennages. Since then the use of composite materials in military and transport aircraft has increased. Initial usage of composite materials to aircraft structures were in secondary structures such as small doors, fairing and control surfaces. As the technology improved, the use of composite materials for primary structures such as wings and fuselage has outstretched.

LITERATURE SURVEY

[1]. Mohammad Arif and his team mates did a review about the composite materials like ‘Carbon and Boran’, ‘Aramid Fibers’ and ‘Metal Matrix Composites’ which are used in applications of aircraft and they concluded that, the composite materials are becoming more important in the construction of aerospace structures. New generation huge aircraft are designed with all composite fuselage and wing structures and the fixing of these advanced composite materials need an complete knowledge of composite structures, materials and tooling. The carbon nanotube technology itself is the greatest test for being able to drive scale to volume and reduce cost.

[2]. B. Lenczowski conducted a test about lightweight alloys i.e., precipitation hard enable Al-Mg-SC-Cu alloys 6013 and 6056 for aircraft structure and he concluded that, the tests of the new aluminium alloys which were discussed in their research paper indicated that they could potentially be used in civil aircraft construction for manufacturing integral fuselage structures by laser-beam welding to achieve weight and cost savings. Which of the recent alloys and in which material combination for e.g. skin-stringer joints will be used in dynamically stressed fuselage regions (where damage sufferance essential) and in stable regions subjected to tensile and compressive forces or corrosive impact can only be determined on the basis of barrel tests, in which actual flight loads are simulated on aircraft fuselage shells.

[3]. Daniel G. Backman and James C. Williams did a research about the advanced materials (super alloys like Rene’ N5, PWA 1484, MERL76, IN718 and CSMX-4) for aircraft engine applications and they concluded that, aerospace technology will continue to grow and play an important role in national security and in civil transportation. Enhanced engines for military aircraft, supersonic civil transport employments, and quieter, cleaner, more fuel-efficient subsonic aircraft are the recent frontiers.

[4]. Robert E. Schifrin and his team mates did a research about the applications of Alloy 718 in GE Aircraft Engines and they concluded that, for GE Aircraft Engines, Inco’s development of Alloy 718 was quite significant and important. Alloy 718 is arguably the most successful super alloy to date. It has been the alloy of choice for affordable components in GEAE's aero engines and land-base derivatives for more than 35 years. Alloy 7 18 possesses a proper combination of toughness and ductility to about 650°C, precipitate stability, weldability, castability and ease

of machining. As we look to the future, the adaptability of Alloy 718 shows its prolonged usage, albeit for a little portion of future engine components due to increasing engine operating temperatures. Discovering a acceptable higher temperature equivalent to Alloy 718 has shown to be a formidable job.

[5]. Melih Cemal Kushan and his team mates did a research about ALLVAC 718 PLUS Superalloy for Aircraft Engine applications and they concluded that, A super alloy is a metallic alloy which is progressed to withstand most of all high temperatures, habitually in cases until 70 % of the absolute melting temperature. All of these alloys have an outstanding creep, corrosion and oxidation resistance as well as a good surface stability and drain life. The most important alloying elements are nickel, cobalt or nickel – iron, which can be found in the VIII group of the periodic system of the elements. Fields of implementations are seen especially in the aerospace industry and in the nuclear industries, e.g. for engines and turbines. The development of these improved alloys permits a better utilization of engines, which function at high temperatures, because the Turbine Inlet Temperature (TIT) hangs on the temperature ability of the material which forms the turbine blades. Nickel-based super alloys can be strengthened through solid-solution and precipitation hardening. Nickel-based super alloys can be used for a higher fraction of melting temperature and are therefore more favourable than cobalt-based and iron-nickel-based super alloys at operating temperatures close to the melting temperature of the materials.

[6]. Nitin P. Padture and his team mates did a review about Thermal Barrier Coatings (Ceramic top coat, Air-plasma-sprayed TBC’s, and Electron-beam physical-vapour deposited TBC’s) for Gas-Turbine Engine Applications and they concluded that, Improved materials will continue to play a major role in meeting the gas-turbine industry’s requirements for improved durability and energy efficiency. Because the implementation of alternate high-temperature structural materials such as ceramics, ceramic composites, intermetallics, and refractory metal alloys is still in the developmental stages, the near-term focus will be on TBCs with improved durability and performance.

[7]. Ramzyzan Ramly and his team mates did a research about the Embedded Fiber Bragg Grating(FBG) Sensors and they concluded that, the material being developed in this research was a honeycomb core-carbon fiber skin sandwich composite panel with embedded FBG sensor for structural health monitoring. In this paper, the process of preparing the specimen was presented. Before the FBG sensor arrays were embedded, the signals were measured using optical FBG scanner. These signals were once again measured using the same equipment after they were embedded in the specimen. The signals were also recorded using Optical Spectrum Analyzer, OSA, to see the wavelength peak shift before and after embedded condition. From the beginning measurement, the test was a success since the FBG sensors were easy to read and the dissimilarity in the signals was less than 1nm. In the future, the specimen will be used for further test(experiment) for measuring strains and creating the existence of defile in the panel.

[8]. Amanico and his team mates did a research about the alloys 2024-T351 and 6056-T4 for the applications of aircraft and they concluded that, Defect-free friction stir welds have been produced for the dissimilar alloys system AA2024-T351/AA6056-T4. Moreover, the temperature measurement techniques used (thermocouples and IR-camera) have

supported the interpretations of microstructural aspects. No or very limited chemical mixing of the BM's in the stir zone could be observed with the experimental techniques used in this investigation. Only a familiar physical contact between BMs was observed. Tensile tests have resulted in reasonable joint efficiencies in terms of ultimate tensile strength but very low efficiency in terms of elongation at the ever. This can be explained in terms of the stress concentration caused by the large difference in strength between BM's, leading to confined plasticity and then, to failure. The TMAZ of AA6056-T4 (weakest region within weld seam) was the location where a crack could initiate and propagate. Microflat tensile tests provided valuable data, which is representative of the local tensile properties for the joint and confirmed the general trend observed in he micro-hardness test results.

[9]. James C. Williams and Edgar A. Strake did a experiment about the progress in structural materials for aerospace systems and they concluded that, The availability of improved materials has enabled the continuous improvement in capability of aircraft and aircraft propulsion. Combination, enhanced materials capability, improved materials processing methods and more efficient design methods account for the existence of modern aircraft that can fly more than 20,000Km non-stop. But the loud sound and emissions from new generation commercial aircraft are considerably lesser than ever before. As the capability of modern aircraft has been enhanced, the simultaneous improvement in reliability of propulsion systems has evolved. The current high levels of reliability in current propulsion systems has enabled twin engine aircraft to fly long over water routes that were previously reserved for three and four engine aircraft. This has added considerable customer value.

[10]. Dr. Ravi B Deo and his team mates did a research about the low cost composite materials (F-16, DASA Mako, B-2, A-320 etc.) and structures for aircraft applications and they concluded that, Simplify design and apply automation to reduce variable fabrication costs. Replace lightly loaded intrinsic stiffeners with Syncore sandwich construction, Utilize fiber placement, performs, and other innovative material forms to decrease the manual lay-up. Design for efficient formulating procedures such as fiber placement and RTM. All aspects of the design and manufacturing procedures must be directed to achieve cheap composite structures.

CONCLUSION

In this paper, all the materials which were used and which are being using now for the aircraft body, engines and structures are neatly described. Many researches are on-going in the development of lightweight materials for the aircraft and aerospace systems. Advanced materials play an vital role in decreasing the environmental impact of aviation. Materials having light weight and high strength to withstand the weight ratio, have improved temperature capability and hence can help to reduce fuel burn and emissions.

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