Nanomaterials for Aviation Industry

Nanotechnology is recognized as a very strong innovation driver and is therefore seen as a strategic technology for the world's future economy.

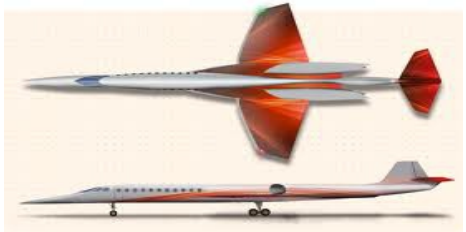
Nanomaterials with their exceptional multifunctional properties may transform the functioning of aviation industry dramatically.

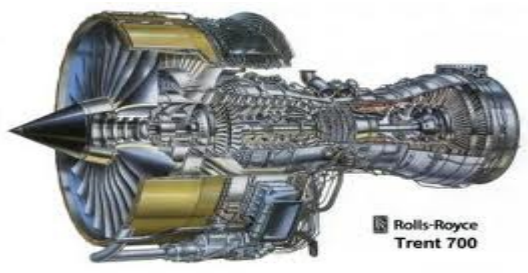
Nanomaterials for different Sectors of Aviation Industry

The success of the Aviation Industry depends on various factors ranging from reduction of weight, availability of materials with multifunctional properties, eco-friendly fuels, less fuel consumption, faster and highly responsive communication systems, less or no repairs, extended and safe life, reduced time frame of development cycle from concept to implementation and many more.

Nanomaterials can be primarily used in three areas of Aviation Industry. These are:

1. **Airframe Structure**
2. **Aero-Engine Parts**
3. **Aircraft Electro-Communication System**





1. Nanomaterials in Airframe Structure

Properties of Materials required for Airframe Structure:

The design requirements of the materials to be used in Airframe Structure are:

Light Weight
High Strength
High Toughness
Corrosion Resistance
Easy Reparability & Reusability
Less Maintenance & Durability

Nanomaterials which can fulfill the requirements:

The modern aviation design requirements like faster, miniature, highly maneuverable, self healing, intelligence guided, smart, eco-friendly, light weight and stealth systems warrant for materials with extraordinary mechanical and multifunctional properties.

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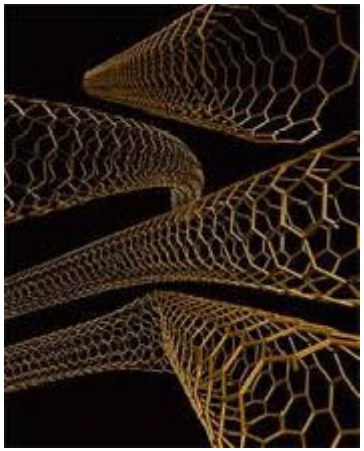
Carbon Nanotube (CNT) based Polymer Composites:

Properties of CNT based polymer composites are their wide range of *Young's Modulus, High Specific Strength, Crash Resistance and Thermal Performance* and these properties can provide conventional composites and light weight metals. Some CNT based composites which can be used for airframe structure are:
CNT/Epoxy, CNT/Polyimide, CNT/PP.



Nanoclays reinforced Polymer Composites:

Properties of these composites are: *Barrier Properties, Thermal and Flame Retardent.*

Metal Nanoparticles incorporated Composites:

The *extraordinary electrostatic discharge and electromagnetic interference (EMI) shielding properties* of these composites make them the probable futuristic solution for making the structure which are *resistant to lightening strikes.*

2. Nanocoatings for Aero-Engine Parts

The coatings are generally used for *protecting the structures and surfaces of the aircraft from harsh environments.* The stringent requirements like *resistance to extreme temperatures, extreme climates, corrosion, abrasion and wear of engine parts* have sparked an increased demand for more reliable high performance coatings.

Some nanomaterials Coatings with improved high-temperature properties may allow higher engine-operating temperatures and therefore improved performance in the future.

SiC Nanoparticles in SiC-particle-reinforced alumina

Yittria stablized nanozirconia

These can facilitate *crack healing, resulting in improved high-temperature, strength and creep resistance* as compared to monolithic ceramics.

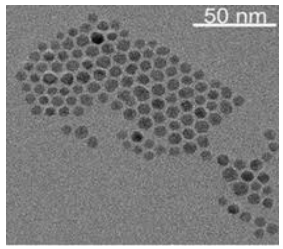
TiN nanocrystallites embedded in amorphous Si_3N_4 are used for *Wear-resistant coatings.*

The nanocomposite coatings made of crystalline Carbide, Diamond like Carbide and metal dichalcogenide, TiN are used for *low friction and wear resistant applications of aircraft.*

Nanotube and nanoparticles (Nanographite, nano)luminium containing polymer coating are used for *electrostatic discharge, EMI shielding and low friction applications of aircraft surfaces.*

3. Nanomaterials for Aircraft Electro-Communication Components

CNTs have unique set of properties, including ballistic electron transport and a huge current carrying capacity, which make them of great interest for future nanoelectronics.



Magnetic Nanoparticles (Iron oxide Nanoparticles i.e. Fe_2O_3 & Fe_3O_4) incorporated polymer films and composites can be used in various *Data Storage Media.*

Ceramic Nanoparticles like Barium Titanate, Barium Strontium Titanate are used for making *Super Capacitors.*

MEMS (Micro Electro Mechanical Systems) and NEMS (Nano Electro Mechanical Systems) offer the possibility of developing a standard fuel management unit which *controls the fuel control in aero-engines.*

4. Nanomaterials for Energy Storage Devices & Ballistic Armours

Carbon Nanotubes (CNTs) have been long heralded as potential candidate for hydrogen storage devices.

CNTs release hydrogen in a control way to generate power.

Ballistic Armours provide protection to the personnel and aircraft from various projectiles. CNTs with their High Ballistic Resistance Capacity, High Energy Absorption Capacity and Multi-Hit Resistance are proved to be the best candidates for making Ballistic Armours.

Some More Applications

Nanoparticles like Nanographite, Nanosilica are extensively used in rubber compounds to prepare Gaskets and Sealants which may find applications in aero engines.

Nanochromium based corrosion inhibitors are being developed for protection of aluminium metalsor aero structures.

Nanopowder of Copper, Aluminium, Iron are being used in the preparation of making conductive plastics which will be used in various components of aircraft where electrostatic discharge of EMI shielding applications are required.

Many nano fibres and textiles are being used in parachutes and aircraft arresters.

Thank you

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