Defence, Aircraft and Space Applications Infosheet

Defence Sector

European defence industry in brief

Facts & Figures about Europe's defence industry

A major industrial sector in Europe:

- Large number of supply chains (system integrators, producers, suppliers)
- At least 1,400 companies
- About 1,400,000 directly of indirectly employed
- Annual sales revenue of almost € 100 billion

High economic and social importance.

Applications

- **Graphite for military helicopters**
- **Graphite for military tanks**
- **Graphite for military aircrafts**
- **Graphite for military lubricant applications**
- **Graphite and carbon fibre for drones and robots**
- **Graphite and carbon fibre for protection of military personnel**
- **Graphite for ammunition**

Weight reduction

Optimising the thrust efficiency of jet engines has a direct impact on the cost of use, making graphite's properties desirable.

Graphite is lightweight, so replacing non-graphite mechanical components with graphite lowers costs. Graphite bearings can be more than 4x lighter than bronze bearings of the same dimensions. Although a small constituent of a jet engine, weight reductions add up over time. Optimizing the weight on a plane's turbines can reduce the amount of fuel needed.

Defence Sector

Extreme Conditions

Carbon and graphite mechanical seals are common in the aerospace industry.

A variety of carbon and graphite products are ideal for aerospace gearbox applications, which run hydraulic pumps, generators, and air conditioning compressors.

To seal the oil lubricant within the gearbox and protect it from leaking where shafts enter and exit, most aircraft gearboxes use face seals, which usually contain a carbon-graphite stationary ring and a silicon carbide or stainless steel rotating ring.

Graphene layers improve dry running – On a microscopic level, graphene layers slide over each other and deposit a burnished film between the graphite and its counter face. This film protects the graphite from roughness on the counter face and is critical in optimising dry wear resistance.

Mechanical graphite in extreme aerospace applications can improve efficiency, cost, and ease of maintenance. Product development is driven by the demand for materials that can withstand higher temperatures, more intense loads and speeds, and longer duty cycles. The materials in these applications need to be self-lubricating, and aerospace engineers often turn to arguably the most versatile self-lubricating material available – high-temperature graphite.

Heat-resistant:

- Carbon graphite aircraft rotors can withstand the high temperatures and extreme conditions within jet engines.
- Graphite tiles inside the NSTX-U resemble those on the space shuttle re-entry vehicle.

Carbon and Graphite Cloth

Design and manufacture carbon and graphite cloth for use in the Aerospace Industry.

The British Ministry of Defence developed activated carbon cloth (ACC) for use in chemical-warfare suits, as it protects the wearer against chemical, biological and nuclear agents. Cutting-edge textile technology. Originally developed for the British Ministry of Defence for use in chemical warfare suits, Activated Carbon Cloth (ACC) has many relevant uses in defence, industrial, and medical applications. In the defence sector is used where protection from a wide range of chemical, biological or nuclear agents is required (i.e. protective clothing, filters and decontamination wipes). Flexzorb® offers the most effective protection on the market today with low physiological burden at low carbon weights.

Aeronautics Sector

Commercial Aircrafts

Civil aeronautics is one of the most successful EU's high-tech sectors. European industry is the world leader in the production of civil aircraft, including helicopters, aircraft engines, parts and components. It provides 405,000 jobs, generates €130 billion in revenues and plays a leading role in exports, amounting to €109 billion (in 2019).

The European aeronautics industry develops and manufactures civil aircrafts, helicopters, drones, aero-engines and other systems and equipment. It also includes companies that provide support services, such as maintenance and training.

Due to the Covid pandemic Commercial flights in the European Union as of August 2022 were 596,930, 14% lower compared to August 2019, when commercial airlines in Europe accounted for 695,912 aircraft. However, the increase in passenger traffic in recent years is likely to propel the growth of commercial aviation in Europe in the coming years.

Commercial aircrafts are used to transport people and goods between countries and states. They face a range of environments from high and low temperatures, rain, humidity, sand, dust, etc. Carbon and graphite provide numerous benefits for aircrafts because they are lightweight, environmentally durable, self-lubricating, oxidation resistant, and have high thermal conductivity. It is commonly used in air bleed valves, jet fuel pumps and meters, and shaft seals in aircrafts. Improvements in carbon technology have allowed aircraft engine manufacturers to design more efficient engines, therefore improving fuel efficiency.

As of 2019, Airbus is the world's largest manufacturer of airliners as well as the leading helicopter manufacturer.

Europe's flagship: The Airbus

405,000 jobs

€130 billion in revenues

Exports amounting to €109 billion

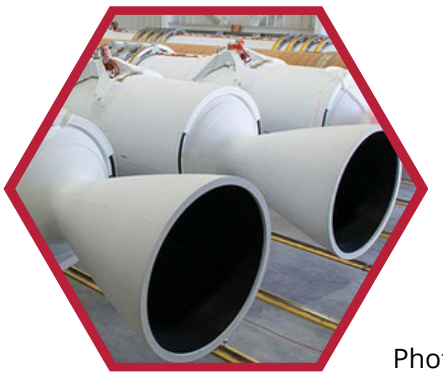
Carbon fibre composites for airplanes

Carbon fibre is a cost-effective way to maintain lightweight, strong, and durable materials in aircraft. Also, applications for carbon fibre are helping aerospace leaders cut costs.
Both, Boeing 787 and the Airbus A350 have been largely made of the innovative material mix of carbon fibres and polymer resins. This trend can also be seen in the small aircraft and helicopter sector.
On top of this, new aerospace applications are coming up such as drones and air taxis. Unmanned aircrafts such as drones offer huge potential for innovative civil applications in a wide variety of sectors that benefit European society, from agriculture to delivery of urgent pharmaceuticals. Within 20 years, the European drone sector is expected to directly employ more than 100,000 people and have an economic impact exceeding €10 billion per year, mainly in services.

Space Sector

Space Applications

Predominantly utilised within space launch applications, carbon and graphite materials have been used within a range of unique and specialised systems including rocket boosters, space shuttle, the International Space Station and the Atlas V programme.



Rocket Motors

The US Delta II was an expendable launch system, originally designed and built by McDonnell Douglas. State-of-the-art automation, robotics, commercial practices, and process controls are used to produce the Graphite Epoxy Motor (GEM) series using graphite fibre. The 40-inch-diameter graphite epoxy motor (GEM 40) is a strap-on booster system developed to provide thrust augmentation for the Delta II launch vehicle.

Photo: Northrop Grumman

Spacecraft Rocket Booster Pumps

Spacecrafts use rocket boosters to escape Earth's gravity. These boosters create powerful explosions using liquid hydrogen and liquid oxygen, which are kept super cold, almost -450ºF. When they mix and burn, they heat up to over 1000ºF. Carbon and graphite are vital because they can handle these extreme temperatures and don't need extra lubricants, which might freeze. Plus, when treated right, they can prevent the super cold fluids from damaging the rocket parts.

Satellites

Around 5,000 satellites circle Earth, enduring harsh space conditions like extreme temperatures and radiation while speeding between 7,000 to 17,500 mph. These satellites need to be lightweight yet sturdy. The main metals used are aluminium and titanium, but materials like graphite, teflon, and carbon fibre also play vital roles. Graphite and teflon act as dry lubricants in space, whereas liquid ones would evaporate. Carbon fibre offers strength without added weight, helping reduce launch costs. Even Europe's Earth-observing Sentinels, part of the Copernicus programme, rely on these materials.

Photo: ESA

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