CORNING

Focus: Aerospace

International applications for advanced ceramics in the aerospace industry

Electrical and structural uses of advanced materials increase globally

Ceramics are increasingly being used in commercial and military aircraft, and have been used in space shuttles for many years.

These materials are generally lighter than metals and thus, have a low mass, which make them highly appealing to the aerospace industry. However, the cost of working with an advanced ceramic material is such that a clear advantage must be established by using it. Once an advantage of using a ceramic has been identified for a product or system, such as being able to run at a higher temperature or increased electrical activity, there are a variety of ceramics available.

Electrical applications

Advanced ceramics underpin the electronics industry and the average aircraft is packed full of electronics. Gradually, these electrical components, such as sensors, antennas, capacitors and resistors, are getting smaller and smaller and more capable. Therefore, this is a major area of development for advanced ceramics.

As far back as the 1990's, the design team of Concorde, the world's then only supersonic airliner, selected a glass ceramic, MACOR®, developed by Corning Incorporated, as it needed a lightweight and electrically insulating technical material for use in the engine control and management system. MACOR® was initially developed by Corning as it wanted a material that is stable at high temperatures and could be machined like plastic.

Structural applications

Structural ceramics, crystalline inorganic non-metals, are used in aerospace as Thermal Barrier Coatings (TBCs) in the hot part of the engine. Or, it is used in composites either as reinforcement and/or as matrix such as CMCs – ceramic matrix composites. Being lightweight and tough tends to be a main driver for using a ceramic composite. From here, engineers need to assess how a composite will perform at an elevated temperature in an air atmosphere and what impact erosion will have on the system and at what rate.

Ceramics are lighter than most metals and stable at temperatures, substantially above high grade technical plastics. As a result of this and other properties, structural ceramic applications include thermal protection systems in rocket exhaust cones, insulating tiles for the space shuttle, missile nose cones and engine components.

Looking for a performing material, the United States' Space Shuttle Orbiter program team decided to use the MACOR® Machinable Glass Ceramic at all hinge points, windows, and doors on the reusable Space Shuttle Orbiter. Also, large pieces of the Corning glass ceramic have been used in a NASA spaceborne gamma radiation detector.

Turbine Applications

Using technical ceramics for various parts of the engine have been looked at for the past 30-40 years. Currently, there is quite a lot of activity in developing silicon carbide (SiC/SiC composites) for use in jet engine turbines, mainly concentrated on the turbine blades. The main driver is fuel efficiency as engineers seek to run the jet engine without the need for cooling channels that currently stop the metal alloy blades from melting. If the blades were made of ceramic composites, which could deal with 1,500-1,600° Celsius, the engine could run at higher temperatures. Therefore, the energy efficiency would increase using less fuel and the airplane could fly further or more efficiently.

To conclude, ceramics are integral to aeronautics and aerospace. They are ubiquitous in the electrical systems and facilitate the drive towards more powerful, yet smaller electrical devices. Structural ceramics are increasing in popularity and deployment. They also offer huge potential for transforming aircraft engine capabilities that could dramatically influence the aeronautics of the future.

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About Corning Incorporated

Corning (www.corning.com/) is one of the world's leading innovators in materials science. For more than 160 years, Corning has applied its unparalleled expertise in specialty glass, ceramics, and optical physics to develop products that have created new industries and transformed people's lives. Corning succeeds through sustained investment in R&D, a unique combination of material and process innovation, and close collaboration with customers to solve tough technology challenges. Corning's businesses and markets are constantly evolving. Today, Corning's products enable diverse industries such as consumer electronics, telecommunications, transportation, and life sciences. They include damage-resistant cover glass for smartphones and tablets; precision glass for advanced displays; optical fiber, wireless technologies, and connectivity solutions for high-speed communications networks; trusted products that accelerate drug discovery and manufacturing; and emissions-control products for cars, trucks, and off-road vehicles.