Plastics in aerospace: the right stuff

PLASTICS IN GOVERNMENT & MILITARY APPLICATIONS

by The Society of the Plastics Industry, Inc.

During the past 50 years, aeronautics technology has soared, with plastics playing a major role in both pragmatic improvements and dramatic advances. In aircraft, missiles, satellites and shuttles, plastics and plastic materials have enhanced and sped significant developments in military air power and space exploration and civilian air travel. For many of the same reasons that make them the materials of choice for such a variety of products that benefit our lives, plastics are the right stuff in aerospace.

From necessity to invention

World War II accelerated the entry of plastics into aerospace both because other materials were scarce and because the possibilities for the materials' use were already being envisioned.

During the war years, vinyl resins became a major substitute for rubber in Air Corps applications such as fuel-tank linings and fliers' boots. Plastics also began to be appreciated as first-choice materials. Virtually transparent to electromagnetic waves, the plastic used in radomes, which housed radar installations, allowed the waves to pass through with minimal loss, maximizing transmission to night-flying bombers. Its introduction was hailed as having significantly advanced the technology of airborne radar.

The United States Coast Guard has added 96 short range HH-65A helicopters to its fleet. They assist in the missions of search and rescue, enforcement of laws and treaties and marine environmental protection. HH-65As are made of corrosion-resistant, composite structure materials. (United States Coast Guard Group, North Bend, OR, USA)

The development of plastics that literally could "take the heat" associated with many aerospace applications and the launching of the U.S. space program spurred additional interest and extensive research in plastics for flight. Soon, plastic materials were common in aerospace for everything from interior trim in airplanes to nose cones for missiles. New words became familiar as "solid fuel boosters" on rockets and "ablative shields" for reentry came to rely on plastic materials. And when man landed on the moon, so did plastics.

Taking off

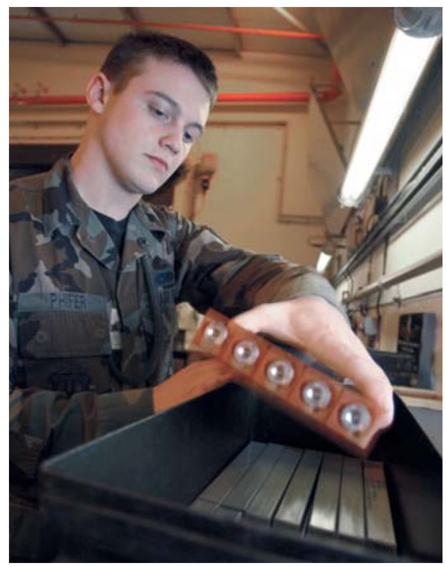
The diversity of plastics and plastic-composite materials provides the characteristics required for a wide variety of aerospace needs. Plastic materials can be flexible enough to withstand helicopter vibration but rigid enough to ensure safe cargo. They can be transparent for easy observation, shatter resistant and offer ballistic protection. And, significantly, they can be both lightweight and strong.

In the 1970s, the oil crisis forced aerospace companies to design aircraft that used less fuel. This meant more efficient engines, improved aerodynamics and reduced aircraft weight. It also meant a role for plastics. Today, jet engine manufacturers increasingly use plastics for the same reasons: reliability, efficiency, fuel savings and improved performance.

The heavier the vehicle, the more fuel it takes to power it. For jetliners, the weight-to-fuel impact is tremendous. Just a one-pound reduction in weight translates into $1,000 in lifetime fuel savings. As composite engines can offer weight reductions of some 300 pounds over other materials, savings can be enormous.

Plastics also save fuel and money because their smooth contours improve aerodynamics. And plastics, which are less expensive to manufacture than heavier materials, produce parts that are more resistant to wear, require less upkeep and are easier to repair.

In the structures, interiors and functional parts of air and space craft, new applications continue to be found for plastic materials, and new plastic materials continue to be created to meet aerospace needs.



Airman 1st Class Chris Phifer finishes building chaff. Chaff is made from strands of plastic coated in aluminum, and is used as a countermeasure from radar-guided missiles. (U.S. Air Force photo by Airman Basic Stacey Jeanpaul)

A show of force

Plastic-composite materials are especially prevalent in today's sophisticated helicopters and other rotor craft. For these aircraft, the toughness, flexibility, crashworthiness and cost savings of plastic materials have motivated their large-scale use, both structurally and mechanically. These vehicles showcase how plastics can be tailored to fit a variety of needs, including opposing ones.

Helicopters, which vibrate a great deal, can be called on to carry heavy payloads of equipment and personnel. The design of these vehicles calls for one set of materials that can compensate for the stresses caused by vibration and another that is stiff enough to hold up under a heavy payload. Plastics can do both, and more.

In military applications of rotor craft, plastics have been on the front lines of innovation. A new entry into the field, the prototype X-wing craft, sports sophisticated plastic-composite wings that act as a rotor during takeoff and landing but lock into a set position once in the air. The stresses inflicted on such a craft are numerous and varied. Only stiff yet light composites can stand up to them. Though developed for military purposes, the X-wing is believed to have potential as a commercial shuttle and to be jet-powered. Other modern military rotor vehicles — including vertical takeoff aircraft, a gunship and a minesweeper — rely heavily on plastic materials to accomplish their specialized tasks.

Plastics also are being, or are expected to be, used extensively for other innovative military craft. One material's near invisibility to radar makes it indispensable for "stealth" aircraft, which designers hope to make undetectable to infrared and optical spotters. And plastic fibers could play a significant role in a proposed blimp that would warn naval forces of surface-skimming missiles. Such vehicles are also being considered for nonmilitary use in fields such as forestry and scientific observation.

Up to the challenge

The air and space craft of the next century increasingly will be made of plastics. Small composite planes will flourish, and commercial aircraft will soar with plastic wings and tails. The military will continue to depend on plastics to create ever lighter aircraft with fewer parts and the ability to evade detection. The Stealth Bomber, for example, uses composites of graphite-like substances mixed with resins to soak up radar energy and transform it to heat, rather than reflect it. (In a more down-to-earth application, the U.S. Army is using a composite heavy-assault bridge that spans 106 feet, supports 70 tons and folds.)

New aircraft designs with rear-mounted engines will rely on plastics to take the stress and better allocate weight. Still lighter materials will increase the crafts' capacities for more sophisticated avionics and other on-board systems. And plastics are expected to answer many of NASA's calls for materials to create and perfect high-performance supersonic/hypersonic aircraft, nuclear space power systems and space stations. ■

The B-2 Spirit is a multi-role bomber capable of delivering both conventional and nuclear munitions. A dramatic leap forward in technology, the bomber represents a major milestone in the U.S. bomber modernization program. The B-2 brings massive firepower to bear, in a short time, anywhere on the globe through previously impenetrable defenses. (U.S. Air Force photo by Staff Sgt. Ken Bergmann)

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