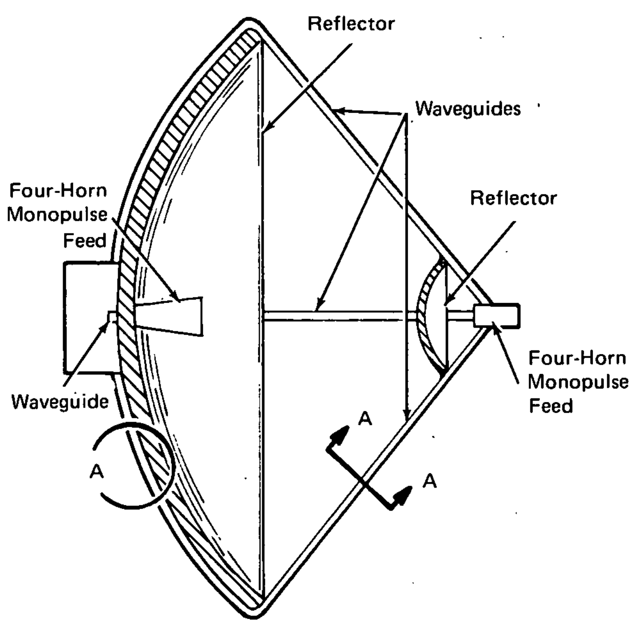
September 1973 B73-10333

NASA TECH BRIEF
Goddard Space Flight Center

Millimeter-Wave Antenna System

The problem:

Surface temperatures in space between the sunlit and shaded regions of spacecraft often differ by as much as 170° C (300° F). This difference creates a nonuniform thermal expansion between the sunlit and shaded sections of satellite antennas which distorts their shape. Antennas designed to operate on a millimeter wavelength are particularly sensitive to this distortion. Their shape cannot be varied by more than 0.1 to 0.5 mm without serious changes in the antenna characteristics. Usually, when a parabolic reflector is distorted, the antenna losses its directional quality and cannot track or provide high-gain data transmission.



Parabolic Reflector Antenna

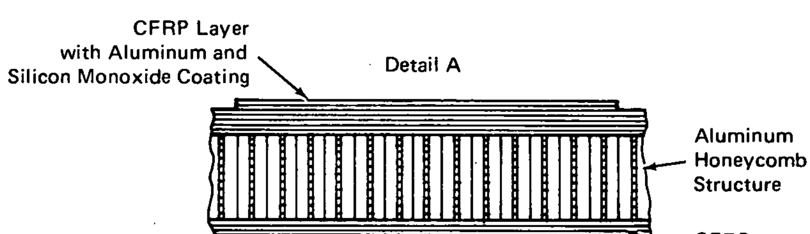
The solution:

Parabolic reflectors fabricated from Carbon Fiber Reinforced Plastic (CFRP) composite material will not distort their shape by more than 3% of the millimeter wavelength, despite the large temperature differences on the reflector surfaces.

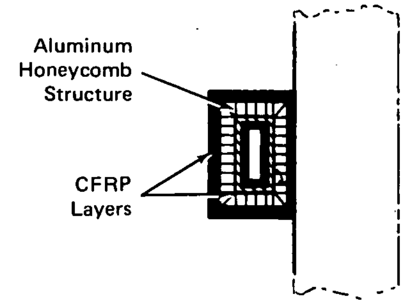
How it's done:

For all practical purposes, the CFRP has a zero thermal expansion. It is derived from charred polyacrylonitrite plastic filaments that are combined with epoxy resin. The composite material is fabricated in relatively thin sheets, with the fibers aligned in a single direction. Typical laminate layups consist of alternating the plies in specific directions. Thus, to provide strength in two orthogonal directions on a single plane, a pair of sheets must be positioned with fibers oriented orthogonally to each other and bonded by epoxy cement.

In the parabolic-reflector antenna (see figure), both reflectors are made from an aluminum honeycomb structure bonded on both sides with laminated layers of CFRP. After the structures are shaped to form



Magnified View of Reflector Structure



Section A-A Magnified View of Waveguide

(continued overleaf)

parabolic reflectors, a thin layer (approximately 400 nm) of aluminum is vacuum deposited on all reflecting surfaces. On top of this, an equally thick layer of silicon monoxide is deposited, to reduce temperature gradients on the reflecting surfaces.

Waveguides on the antenna that extend to four-horn monopulse feed are also constructed from the same material as the reflector. Each waveguide wall contains the honeycombed aluminum structure enclosed by layers of CFRP. Aluminum is also deposited in waveguide cavities. Waveguides are attached to the antenna structure with epoxy cement.

Because of the CFRP construction, the antenna provides an excellent dimensional stability and easily withstands temperature differences of 170° C. This construction is particularly suitable for antennas designed for millimeter wavelength range.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
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Greenbelt, Maryland 20771
Reference: TSP73-10333

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,716,869). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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